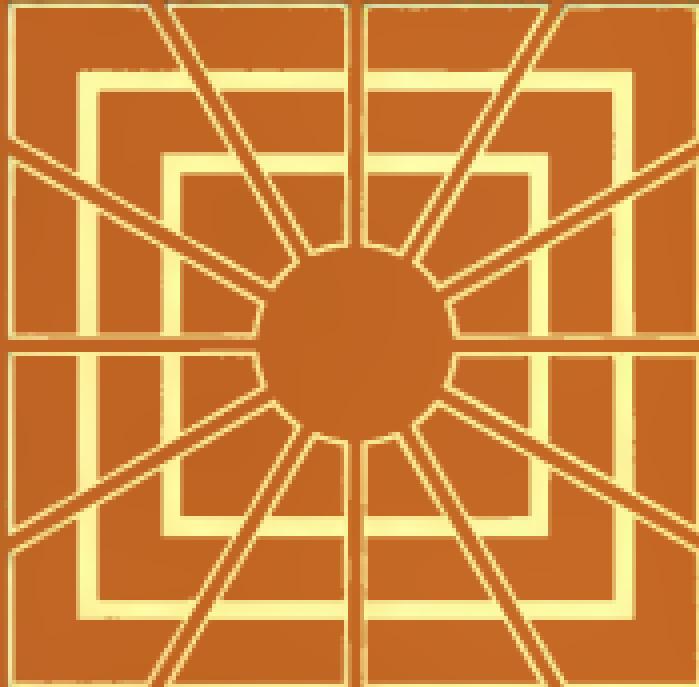
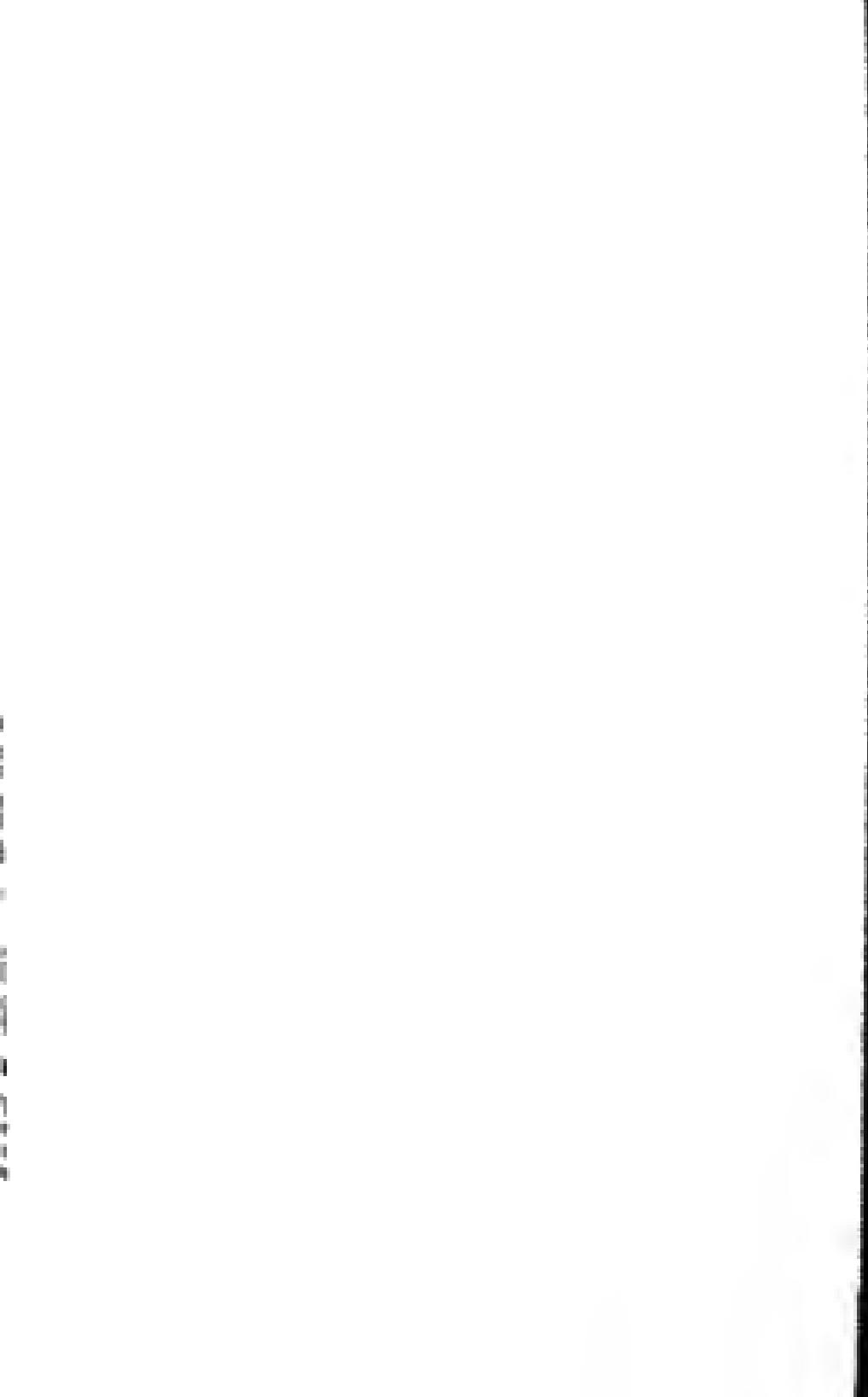


Microcomputer Vendor Directory



Software · Hardware



Microcomputer Vendor Directory

Software/Hardware



Microcomputer Vendor Directory

Software /Hardware

**Produced by the Editorial Staff of
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INTRODUCTION

Auerbach Publishers has designed this Microcomputer Vendor Directory to provide you with a current and conveniently organized listing of microcomputer software, hardware, and peripherals vendors.

Once you have selected the software package or system that best satisfies your requirements, you are encouraged to use this Directory to save time and effort when contacting vendors.

The first section alphabetically lists all the microcomputer vendors featured in Auerbach's MicroWorld service, with the complete vendor name, street address, city, state, zip code, and telephone number. In addition we have provided the generic type of micro software and hardware currently offered by each vendor.

The second section, which lists microcomputer vendors by the products they offer, is organized according to specific hardware and software categories, such as accounts payable software, or accounts receivable software, or diskettes. All vendors who market products under a given category are listed in alphabetical order.

The last section comprises a handy glossary of terms and features articles that address the application of micros in a variety of environments. The glossary provides you with the vocabulary you'll need to communicate effectively with the vendors you've located in the Directory. It also explains the abbreviations used in your MicroWorld service.

AUERBACH PUBLISHERS INC

Data processing and business professionals turn to Auerbach for reliable and current information to aid cost-effective, sound purchasing and management decisions.

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Alphabetic Vendor Directory

ALPHABETIC VENDOR DIRECTORY

AB COMPUTERS

Software: Data Base Management

253 Bethlehem Pike
Colmar PA 18915
(717) 622-7727

ABLE COMPUTER

Hardware: Microcomputers

1732 Reynolds Ave
Invina CA 92314
(714) 577-7820

ABSTRACT SYSTEMS

Software: Data Communications

1810 Lower Prospect Hill
Cresser MA 01211
(413) 284-7750

ADW

Software: Data Base Management

PO Box M1647
Ann Arbor MI 48106
(313) 571-2964

ACCELERATED DATA SYSTEMS

Hardware: Microcomputers

1183 Rockwood
Suite 10
Sonoma CA 94506
(415) 784-0264

ACCENT SOFTWARE

Software: Graphics

2750 Wright St
Palo Alto CA 94303
(415) 855-4265

ACCESS TECHNOLOGY

Software: Budgeting/Forecasting

6 Pleasant St
South Natick MA 01760
(508) 625-3910

ACCOUNTANTS MICROSYSTEMS

Software: Payroll/Personnel, Integrated Accounting,
Professional Services

1404 14th St NE
Baltimore MD 21207
(301) 540-2990

ACCOPIPE

Software: Graphics

222 W Lancaster Ave
Wayne PA 19087
(717) 299-7345

ACE COMPUTER PRODUCTS

Software: Data Communications

1140 River 3rd St
Daytona Beach FL 32117
(305) 437-1217

ACME SOFTWARE

Software: Sales/Orderentry

1737 N 35th Street
Suite 230
San Jose CA 95110
(408) 266-5830

ACDEN COMPUTERS LTD

Hardware: Microcomputers

1a Market Hill
Cambridge
England CB2 3HJ
Telephone: (020) 2419299

ACORN SOFTWARE PRODUCTS

Software: Utilities

634 N Carolina Ave #2
Washington DC 20003
(202) 463-4300

ACTION COMPUTER ENTERPRISE

Hardware: Microcomputers

33 W Del Mar Blvd
Pleasanton CA 94560
(415) 793-3445

ACTIVE COMPUTER ENTERPRISES

Software: Data Base Management

1953 East Apache Blvd
Tempe AZ 85281
(602) 948-2359

ADDISON-WESLEY PUBLISHING

Software: Budgeting/Forecasting

Jacobs Way
Reading MA 01867
(508) 344-2720

ADVANCED DATA SYSTEMS

Software: Data Communications

Field Magic Corp.
St. Louis MO 63143
(314) 785-5288

ADVANCED MANAGEMENT STRATEGIES

Software: Budgeting/Forecasting

Suite 200
1900 Clark Valley Way
Atlanta GA 30337
(404) 448-4817

ADVANCED MICRO DEVICES

Hardware: Microprocessors

901 Thompson Pl.
Sunnyvale CA 94086
(408) 733-1400

ADVANCED STRUCTURAL TECHNOLOGY

Software: Engineering/Scientific

PO Box 11650
Clayton MO 63115
(314) 733-4382

ADVENTURE INTERNATIONAL

Software: Language

Box 3465
Longwood FL 32750
(305) 865-3111

AEM COMPUTER SERVICES

Software: Professional Services

12811 E Charter Oak Rd.
Scottsdale AZ 85254
(602) 952-8202

AERONICA

Software: Professional Services

Encourant
4500 Park Rd Suite 100
Charlotte NC 28209
(704) 329-8888

AJ SOFTWARE SERVICES

Software: Professional Services

1106 Crossfield Circle
Canton IL 61520
(312) 222-0700

AGDATA

Software: Professional Services

891 Hazel St.
Corte Madera CA 94925
(415) 648-4200

AGRICULTURAL MANAGEMENT SYSTEMS

Software: Professional Services

2770 Vista Ave.
Boise ID 83705
(208) 346-4366

AK ROSENHAN, CONSULTING ENGINEER

Software: Professional Services

Orchard Rd.
Minnesota State MG 35942
(612) 425-1888

ALCOR SYSTEMS

Software: Language

800 West Garland Avenue Suite 100
Garland TX 75040
(214) 469-1016

ALEXANDER GRANT & CO

Software: Integrated Accounting

225 Capitol Mall
Suite 100
Sacramento CA 95814
(916) 441-7222

ALPHA MICRO

Hardware: Microcomputers, Diskettes, Address Memories

17801 Sky Park N.
PO Box 15047
Rancho CA 91370
(714) 757-1404

ALPHA OMEGA COMPUTER SYSTEMS

Hardware: Microprocessors

23071 Sprague Circle
PO Box 10
Corvallis OR 97330
(503) 734-1571

ALPHABIT COMMUNICATIONS

Software: Graphics, Modem/Processing/Text Editing

11601 Michigan Ave.
Dearborn MI 48126
(313) 221-2000

ALTOS COMPUTER SYSTEMS

Hardware: Microcomputers

2360 Sterling Dr.
San Jose CA 95131
(408) 946-4700

AMERICAN BELL

Software: Utilities

Headquarters Plaza
One Spearhead Ave Box 5211
Montgomery AL 36190
(334) 859-5527

AMERICAN BUSINESS SYSTEMSSoftware: Accounts Payable, Accounting, Receivable,
General Ledger, Payroll/Pension,

Sales/Inventory
3 Underhill Rd
Westford MA 01886
(508) 693-2600

**AMERICAN COMPUTERS &
ENGINEERS**

Software: Graphics

Hardware: Microcomputers

2021 Buntington Ave #204
Los Angeles CA 90025
(213) 477-0751

AMERICAN PLANNING

Software: Languages

4600 Duke St.
Suite 400
Alexandria VA 22314
(703) 739-2074

AMIFEX

Hardware: Workstations

Memory Products Div
208 N High St
El Segundo CA 90245
(310) 649-9159

ANACOMP

Software: Manufacturing

13000 N 40th Pl
Bellevue WA 98005
(206) 451-4990

ANADEX

Hardware: Printers

1625 De Sales Ave
Chatsworth CA 91311
(213) 884-6010

ANATROL

Software: Engineering/Scientific

Suite 227
11000 Reed Hartman Highway
Cincinnati OH 45242
(513) 964-3880

ANDENT

Software: Professional Services

1026 North Ave
Madison WI 53703
(608) 244-0272

ANDERSON JACOBSON

Hardware: Desktop, Printers

370 Churchill Ave
San Jose CA 95131
(408) 264-6129

ANDROMEDA SYSTEMS

Hardware: Add-on Massstorage

1020 Rose Ave
Cupertino CA 95124
(415) 259-7600

ANDROMEDA SYSTEMS

5000 Rose Ave
Cupertino CA 95124
(415) 259-7600

ANOTHER DIRECTION

Software: Professional Services

19 Belling Road
East Brunswick NJ 08816
(201) 238-1333

ANTHO-DIGITAL

Software: Utilities

102 Bantam Avenue
Westfield MA 01081
(413) 468-8278

APPARAT

Hardware: Add-on Massstorage

4401 S Tamarac Pkwy
Denver CO 80212
(303) 741-1778

APPEL & KREISS SOFTWARE

Software: Professional Services

71 Alvar St Ste 100
Woodland Park CO 80501
(303) 434-7137

APPLE COMPUTERSoftware: Graphics, Operating Systems, Languages
Hardware: Microcomputers, Workstations, Diskdrives, Printers

10240 Sandley Dr
Cupertino CA 95014
(408) 296-1030

APPLIED DIGITAL DATA SYSTEMS

Software: Microcomputers

100 Marcus Blvd.
Hauppauge NY 11788
(516) 221-5422**APPLIED MICROCOMPUTER SYSTEMS**Software: Word Processing/Text Editing
Box 100
Silver Lake MI 48201
(313) 867-4034**APPLIED SOFTWARE TECHNOLOGY**Software: Data Base Management
10125 Cappi Dr.
Suite 4
Los Gatos CA 95038
(408) 375-3642**APPLIED SYSTEMS**Software: Professional Services
Microbase: Microcomputers
34621 Haugen
Suite 1
3a Clear Shores Rd. 40381
(313) 279-6200**APPLIED TECHNOLOGY VENTURES**Software: Word Processing/Text Editing
410 National City
14th Bldg.
Cleveland OH 44114
(216) 529-2525**ARbutus TOTALSOFT**Software: Professional Services
4020 Guide Meridian
Suite 214
Bellingham WA 98226
(360) 731-0400**AEGOS SOFTWARE**Software: Job Costing, Integrated Accounting
780 W. Shaw Ave.
Suite 360
Fresno CA 93704
(209) 221-0271**ARM**Software: Professional Services
1345 Northwest 52 Street Suite 111
Miami FL 33136
(305) 594-2925**ARROW MICRO SOFTWARE**

Software: Data Communications

11 Kingbird
Kanata ON K2B 1T9
Canada
(613) 591-4626**ARTSOL**

Software: Word Processing/Text Editing

2547 Saratoga Ave.
North Hollywood CA 91601
(213) 981-2022**ASHTON-TATE**

Software: Budgeting/Forecasting, Data Base Management

10150 W. Jefferson Blvd.
Culver City CA 90230
(213) 204-5200**ASK MICRO**Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll Personnel, Integrated
Accounting, Sales/Distribution100 Blue Avenue Rd.
Palo Alto CA 94303
(415) 969-6233**ASPEN SOFTWARE**Software: Program Development/Debugging
PO Box 499
Tulare NM 87301
(505) 731-1121**AST RESEARCH**Hardware: Add-on Boards
2072 Mirana Ave.
Irvine CA 92714
(714) 542-1220**ASTROCOM**Hardware: Modems
120 W. Plaza
St. Paul MN 55107
(612) 227-6651**ATARI**Software: Word Processing/Text Editing
Hardware: Microcomputers, Modems
1345 Saratoga Ave.
PO Box 427
Sunnyvale CA 94086
(408) 229-6547**ATASI**Hardware: Workstations
228 Charles Ave.
San Jose CA 95111
(408) 542-4770

ATON INTERNATIONAL

Software: Word Processing/Text Editing, Operating Systems, Data Communications
 360 Brookside Ave.
 San Jose CA 95136
 (408) 296-6578

AUTODESK

Software: Graphics
 16 St. Jude Rd.
 Mill Valley CA 94941
 (415) 567-1875

AUTOCGRAPHIX

Software: Graphics
 100 Fifth Ave.
 New York NY 10018
 (212) 820-4526

AUTOMATED INSURANCE RATING SERVICES

Software: Budgeting/Forecasting
 801 Bandy Blvd Suite 100
 Carrollton TX 75007
 (214) 462-0910

AUTOMATED RESOURCE MANAGEMENT

Hardware: Workstation
 3612 W. MacArthur Blvd.
 Santa Clara CA 95051
 (707) 850-9281

AZURDATA

Hardware: Printers
 4102 148th Ave NE
 Redmond WA 98052
 (206) 851-5700

B-SQUARED

Software: Sales/Order Systems
 PO Box 26214
 Tempe AZ 85282
 (602) 839-9999

BARRINGTON INTERNATIONAL

Hardware: Microcomputers
 728 Airport Blvd
 Suite 4
 Ann Arbor MI 48104
 (313) 769-7611

BASF SYSTEMS

Hardware: Workstation
 Crosby Dr.
 Bedford MA 01730
 (617) 271-4100

BASIS

Hardware: Microcomputers
 3400 Scotts Valley Dr.
 Scotts Valley CA 95066
 (408) 428-3804

BEAMAN PORTER

Software: Word Processing/Text Editors
 Pleasant Ridge Rd.
 Wantagh NY 11793
 (516) 947-3304

BERNARD GIFFER ASSOCIATES

Software: Manufacturing
 34 Linda Lane
 Worthington PA 16667
 (218) 340-2343

BGL TECHNOLOGY

Hardware: Disk Drives
 15452 Cobalt Rd.
 Suite 207
 Van Nuys CA 91408
 (213) 767-0525

BILLINGS COMPUTER

Hardware: Microcomputers
 16620 E. 20th Terrace-3
 Independence MO 64050
 (816) 273-0800

BINKLEY SOFTWARE

Software: Engineering/Scientific
 7346 Sharon Dr.
 San Jose CA 95129
 (408) 257-1232

BIZCOMP

Hardware: Modems
 PO Box 7488
 North Park CA 94602
 (415) 745-1888

BLACKHAWK COMPUTERS

Hardware: Microcomputers
 212 19th St.
 Sacramento CA 95814
 (916) 323-5557

BMC COMPUTER

Hardware: Microcomputers
 860 E. Walnut St.
 Carson CA 90746
 (310) 333-2829

BPI SYSTEMS

Software: Integrated Accounting
 2402 Goodridge
 Austin TX 78756
 (512) 454-2801

BREEZE/QSD

Software Graphics, Utilities

11400 Research Expressway
Suite 125
Dallas TX 75229
(214) 464-2876

BRISTOL INFORMATION SYSTEMS

Software: Accounts Receivable, Payroll/Personnel,

Sales Distribution, Professional Services
24 North Main Street
Fall River MA 02720
(508) 679-1881

BRÖDERBUND SOFTWARE

Software: Word Processing/Text Editing

1958 Fourth St.
San Rafael CA 94901
(415) 454-4424

BURROUGHSSoftware: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales DistributionHardware: Microcomputers
Burroughs PL
Desert View 48220
(313) 572-7800**BUSINESS & PROFESSIONAL SOFTWARE**

Software: Graphics

140 Brattle St.
Cambridge MA 02140
(617) 491-3377

BUSINESS PLANNING SYSTEMS

Software: Budgeting/Forecasting

Two N State St.
Dover DE 19901
(302) 734-5200

BUSINESS SOLUTIONS

Software: Budgeting/Forecasting

401 Main St.
King of Prussia PA 19406
(484) 359-1120

BYTEK

Software: Program Development/Debugging

1714 Sollers Ave
Berkeley CA 94707
(415) 823-1137

C&H VIDEO

Software: Graphics

110 W Clinton Ave
Hershey PA 17033
(717) 523-9480

CADO SYSTEMS

Software: Professional Services

Hardware: Microcomputers

2771 Toledo St.
Romoland CA 92380
(714) 300-1940

CALIFORNIA DIGITAL ENGINEERING

Software: Word Processing/Text Editing

PO Box 525
Hollywood CA 90028
(213) 461-2221

CALLAN DATA SYSTEMS

Hardware: Microcomputers

3407 Fairwaygate Rd.
Westlake Village CA 91361
(800) 551-9736

CAMBIEX

Hardware: All-in Micros

360 Second St.
Wellesley MA 02481
(617) 260-4200

CAMPBELL SCIENTIFIC

Hardware: Microcomputers, Printers, Modems

PO Box 551
Logan UT 84321
(800) 759-2442

CANON USA

Hardware: Microcomputers

One Canon Plaza
Lake Success NY 11042-0077
(516) 489-4700

CARBO

Hardware: Microcomputers

12201 Pala Dr.
Carmel Valley CA 92010
(619) 599-1105

CASIO

Hardware: Microcomputers

15 Gardner Rd.
Fairfield NJ 07006
(201) 377-7400

CAXTON SOFTWARE PUBLISHING

Software Data Base Management
18-24 Bedford Street
Covent Garden
London WC2E 3HT
England

CENTRAL DATA

Hardware: Microcomputers, Add-in Memory
1603 University Dr
Champaign IL 61820
(312) 394-6276

CENTRONICS DATA COMPUTER

Hardware: Printers
1 Wall St
Hudson NH 03051
(603) 863-0111

CENTURION COMPUTER

Hardware: Microcomputers
1002 E Apache Rd
Richardson TX 75261
(214) 934-1779

CERMETEK

Hardware: Modems
1308 Sonoma Ave
Sunnyvale CA 94086
(408) 734-6590

CHANG LABORATORIES

Software: Budgeting/Forecasting
10330 N Stelling Rd
Cupertino CA 95014
(408) 731-6288

CHARLES RIVER DATA SYSTEMS

Hardware: Microcomputers
4 Tech Circle
Natick MA 01760
(508) 625-1800

CHRISLIN INDUSTRIES

Hardware: Microcomputers, Diskette, Add-in Memory
30552 Via Colleen
No 101
Westlake Village CA 91362
(805) 961-0304

CHROMATICS

Hardware: Microcomputers, Add-in Memory
2000 Mountain Industrial Blvd
Tucker GA 30084
(404) 463-7000

CIRRUS SYSTEMS LTD

Hardware: Microcomputers
Avon Way, Borehamwood
Hertfordshire, UK WD6 4PF
England 0925 762641
Telephone: (0125) 762641

CLIENT ACCOUNTING SYSTEMS

Software: Professional Services
3301 Hwy 406 Ave #210
 Ft Lauderdale FL 33313
(305) 733-2127

CMA MICRO COMPUTER

Software: Professional Services
33722 Santa Fe Trail
Yucaipa Valley CA 92399
(909) 349-5716

CMV SOFTWARE SPECIALISTS

Software: Professional Services
303 W Russell
Snowflake AZ 85937
(602) 386-6681

COASTAL COMPUTER

PO Box 501
102 Lufkin Rd
Hempstead NY 11540
(516) 526-4526

CODEX

Hardware: Modems
20 Cedar Blvd
Mansfield MA 02048
(508) 344-2000

COHERENT COMMUNICATIONS

Hardware: Modems
40 Commerce Dr
Hauppauge NY 11788
(516) 481-4074

COLONIAL DATA SERVICES

Hardware: Microcomputers
105 Sanford St
Hamden CT 06514
(203) 289-2374

COLUMBIA DATA PRODUCTS

Hardware: Microcomputers
2990 Route 108
Champlain NY 12919
(518) 992-3400

COMARK

Software: Microcomputer, Workstation, Diskette
150 Crescent St
Wellesley MA 01841
(617) 484-7002

COMDATA

Software: Utilities
1600 1/4 Maple Ave
Menlo Park CA 94025
(415) 470-9600

COMMODORE BUSINESS MACHINES

Software: Microcomputer, Utilities, Add-in Modules, Printers, Modems
407 Devon Park Dr
Wayne PA 19087
(215) 681-9700

THE COMMUNI TREE GROUP

Software: Data Communications
470 Castro
Suite 207-300
San Francisco CA 94114
(415) 474-0800

COMPAC SYSTEMS

Software: Word Processing/Text Editing
59 E Cunningham Dr
Palatine IL 60067
(312) 395-8666

COMPAL COMPUTER SYSTEMS

Hardware: Microcomputer
1000 Wilshire Blvd
Beverly Hills CA 90211
(213) 622-2800

COMPAQ COMPUTER

Hardware: Microcomputer
12000 Ferry Rd
Houston TX 77090
(713) 460-7700

COMPLETE COMPUTER SYSTEMS

Software: Word Processing/Text Editing
139 Callejon Rd
Prudential Business Campus
Huntington PA 16044
(716) 447-4000

COMPUGRAPHIC

Software: Accounts Receivable
200 Euclid Ave St
Wilmington MA 01887
(978) 656-5600

COMPUHAIX

Software: Microcomputer, Manufacturing, Data Base Management
PO Box 7238
Alameda Park CA 94022
(415) 554-6200

COMPUPRO

Hardware: Microcomputer
860 7th St PO Box 2799
Oakland Airport CA 94614
(415) 582-0236

COMFUSOL

Software: Professional Services
11 Center Sq A109
1444 Sutter Hwy
Corte Madera CA 94925
(415) 471-4223

COMPUTEK

Software: Word Processing/Text Editing
11 Second Ave
Wellesley MA 01843
(508) 272-6100

COMPUTER ANCILLARIES LTD.

Hardware: Microcomputer
64 High St
Bognor Regis
England WA2 8QY
Telephone (01264) 4455

COMPUTER: APPLICATIONS

Software: Data Communications
11600 1st St Ste 200 Circle
Edison NJ 08818
(201) 248-4277

COMPUTER AUTOMATION

Hardware: Microcomputer
3181 Dupont Dr
Indio CA 92203
(760) 363-8830

COMPUTER CONSULTING SERVICES

Software: Professional Services
1602 Deer St
Cleves OH 45032
(513) 446-2640

COMPUTER CONTROL SYSTEMS

Software: Utilities
250 21st Terrace St
Largo FL 33541
(305) 566-2990

COMPUTER DATA

Software: Program Development/Debugging
 136 Hanover St.
 Wrentham MA 02380
 (508) 738-5262

COMPUTER DEVELOPMENT

Software: Word Processing/Text Editing
 4700 SW 18th St.
 Beaverton OR 97005
 (503) 648-1279

COMPUTER DEVICES

Hardware: Microsystems, Printers
 Two Park Plaza
 Suite 1000
 New York NY 10121
 (212) 685-3255

COMPUTER EXTENSION SYSTEMS

Hardware: Microsystems
 17910 E. Camino Real
 Suite 130
 Houston TX 77068
 (713) 485-5529

COMPUTER HEADWARE

Software: Data Base Management
 PO Box 14494
 San Francisco CA 94141
 (415) 467-6718

COMPUTER INNOVATIONS

Software: Languages
 10 Mechanics St.
 Suite 1-HDX
 Redwood City CA 94061
 (415) 530-0965

COMPUTER MARKETING SERVICES

Software: Desktop Publishing, Word Processing/Text Editing
 300 W Melton Plaza
 Cherry Hill NJ 08002
 (609) 795-1480

COMPUTER METHODS

Software: Manufacturing
 1000 W. Oklahoma Ave.
 Milwaukee WI 53227
 (414) 227-4671

COMPUTER METHODS OF PENNSYLVANIA

Software: Program Development/Debugging
 323 Hanover Road
 King of Prussia PA 19406
 (717) 365-2260

COMPUTER OPTIONS

Software: Job Control
 140 Crescent St.
 Revere MA 01903
 (617) 481-5447

COMPUTER PRODUCTS

Software: Hypertext/terminal, Program Development/Debugging
 3225 Cherry Park
 New Orleans LA 70120
 (504) 453-5350

COMPUTER STATIONS

Software: Graphics, Data Communications
 11611 Page Service Drive
 St. Louis MO 63141
 (314) 432-7079

COMPUTER SYSTEMS ASSOCIATES

Hardware: Workstations
 7802 Trade St.
 San Diego CA 92121
 (714) 224-2881

COMPUTER TASK GROUP

Software: Relational Services
 880 Delaware Avenue
 Buffalo NY 14208
 (716) 822-6200

COMPUTER TRANSCIEVER SYSTEMS

Hardware: Printers
 1440 Willard Ave.
 PO Box 15
 Paterson NJ 07502
 (201) 361-4820

THE COMPUTERIST

Hardware: Microsystems
 PO Box 3
 34 Chalmers St.
 S Chalmers Rd. 01024
 (507) 256-3449

COMPUTERS INTERNATIONAL

Hardware: Printers
 3340 Wilshire Blvd.
 Los Angeles CA 90006
 (213) 386-1111

COMPUTHINK

Hardware: Microcomputers
 500 West Maude Ave.
 Sunnyvale CA 94088
 (408) 243-6223

COMPUTING

Software, Utilities

2119 Greenwich Street
San Francisco CA 94123
(415) 567-1624

COMPUTONE SYSTEMS

Software: Financial Services

One Dunwoody Park
Atlanta GA 30338
(404) 363-3010

COMREX INTERNATIONAL

Hardware: Printers, Display Monitors

1001 Shoppes Dr.
Suite 100
Torrance CA 90508
(213) 579-0200

COMSHARE

Software: Budgeting/Forecasting

1001 S State St.
Aven. Atrium #4 48154
(313) 595-4800

COMSHARE TARGET SOFTWARE

Software: Budgeting/Forecasting

7105 Old Valley Way
Suite 200
Atlanta GA 30339
(404) 634-1625

CONDOR COMPUTER

Software: Data Base Management

2051 S State St.
Aven. Atrium #4 48154
(313) 769-2988

CONSTRUCTION DATA CONTROL

Software: General Ledger, Payroll/Personnel, Job Costing, Integrated Accounting, Word Processing/Text Editing, Data Base Management

2050 Western Rd.
Tucker GA 30084
(404) 554-4722

CONTEXT MANAGEMENT SYSTEMS

Software: Budgeting/Forecasting, Data Communications

12844 Hawthorne Blvd.
Suite 100
Torrance CA 90509
(313) 378-6227

CONTINENTAL SOFTWARE

Software: Accounts Receivable, General Ledger

11220 South Hindley Ave
Los Angeles CA 90064
(415) 412-1921

CONTROL DATA

Hardware: Microcomputers

10100 34th Ave S
Minneapolis MN 55440
(612) 853-6120

CONTROL LOGIC

Hardware: Microcomputers

9 Tech Circle
Markham MA 01747
(507) 422-1170

COPNUCOPIA SOFTWARE

Software: Word Processing/Text Editing

P.O. Box 5208
Plymouth MA 02360
(617) 534-0096

CORVUS SYSTEMS

Hardware: Microcomputers, Workstations

2000 CiraCircle Ave
San Jose CA 95131
(408) 946-0700

COSMOPOLITAN ELECTRONICS

Software: Operating Systems

P.O. Box 214
Plymouth MA 02360
(617) 528-4460

COVINGTON COMPUTER SALES

Software: Graphics

201 Pleasant Park Rd.
Ottawa ON K2B 2A7
Canada
(613) 747-0844

CP/M USERS GROUP

Software: Data Communications

1601 Third Avenue
New York NY 10026
(212) 730-1286

CREATIVE SOLUTIONS

Software: Program Development/Designing

4201 Randolph Rd.
Knoxville TN 37917
(615) 584-0342

CROMEMCO

Software: Graphics, Word Processing/Text Editing, Mathematics, Microcomputer, Add-in Modules
188 Bernardo Ave
Mountain View CA 94031
(415) 964-7400

CYBERIA

Software: Professional Services, Data Communications
2330 Lincoln Way
Ames IA 50010
(515) 292-7634

CYBERSYSTEMS

Hardware: Microcomputers

8200 Whitehurst Dr
Huntsville AL 35802
(205) 581-4450

CYMA

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Integrated Accounting, Professional Services
1910 E University Dr
Tempe AZ 85281
(602) 963-6860

CYNTHIA PERIPHERAL

Hardware: Winchester

3606 1/2 Bayshore Rd
Palo Alto CA 94303
(415) 856-5181

CYPHER COMMUNICATIONS TECHNOLOGY

Software: Data Communications

Suite 1000
1711 1/2 Hwy
Washington DC 20006
(202) 347-0204

DAIKINS

Software: Budgeting/Forecasting, Professional Services, Program Development/Debugging

2475 Dahlia St
PO Box 23187
Denver CO 80221
(303) 429-4000

DATA ACCESS

Software: Program Development/Debugging
4221 Ponce De Leon Blvd
Coral Gables FL 33146
(305) 446-3649

DATA BASE RESEARCH

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Sales Distribution
66 N Van Gorden
Suite 100
Lakewood CO 80401
(303) 467-4260

DATA GENERAL

Software: Accounts Receivable, Sales Distribution
Hardware: Microcomputers
4400 Computer Dr
Westboro MA 01581
(508) 364-6911

DATA SYSTEMS & SOFTWARE GROUP

3 Research Office Park
Suite 100
Birmingham AL 35244
(205) 969-1957

DATA TERMINAL SYSTEMS

Hardware: Microcomputers

124 Action St
Maynard MA 01754
(508) 867-3271

DATA TERMINALS & COMMUNICATIONS

Hardware: Printers

390 Division St
Campbell CA 95008
(408) 351-1712

DATAGRAPH

Software: Graphics

728 Highway 4 Suite 2
PO Box D
Aptos CA 95003
(408) 758-5104

DATAMAC COMPUTER SYSTEMS

Hardware: Microcomputers, Add-in Modules

440 Almanor Ave
Sunnyvale CA 94088
(408) 733-6523

DATAMARK BUSINESS SYSTEMS

Software: Data Communications

219 S McKnight Rd
St Paul MN 55119
(612) 739-7771

DATAMED RESEARCH

Software: Word Processing/Text Editing, Utilities
1453 Research Rd
Los Angeles CA 90024
(213) 471-4823

DATAMEDIA**Hardware** Microcomputers7401 Central Highway
Pittsburgh PA 15207
(412) 683-0400**DATAMOST****Software** Word Processing/Text Editing5001 Century St.
Cupertino CA 95011
(408) 549-1207**DATAPOINT****Hardware** Microcomputers, Printers, Modems9025 Datapoint Dr.
San Antonio TX 78264
(512) 499-7332**DATAPRODUCTS****Hardware** Printers1000 Congress Ave.
PO Box 746, MS 2002
Woodland Hills CA 91365
(213) 867-8000**DATASOFT****Software** Graphics19679 Business Dr.
Northridge CA 91349
(213) 708-5961**DATASOUTH****Hardware** PrintersPO Box 140947
4250 Steam Andrew Blvd.
Charlotte NC 28227
(704) 523-6300**DATATEK****Software** Word Processing/Text Editing3601 Enterprise Rd.
Cleasanton FL 33521
(800) 337-5224**DATATRONIX****Hardware** Modems2000 Bremo Ave.
Brenton VA 24061
(800) 438-5300**DATAVUE****Hardware** Microcomputers1911 12th Ave S.
Seattle WA 98101
(206) 222-5330**DATEC****Hardware** Modems2500 Balsam Dr.
Suite 118
Chapel Hill NC 27514
(919) 599-2133**DATICON****Hardware** Microcomputers150 "B" Ave.
Lake Oswego OR 97034
(503) 636-7671**DAVONG SYSTEMS****Hardware** Add-on modules1000 Terra Bella Ave.
Mountain View CA 94031
(415) 967-7130**DECISION RESOURCES****Software** GraphicsPO Box 308
Weston CT 06881
(203) 227-1574**DEDICATED SYSTEMS****Software** Program Development/Debugging2440 East Commercial Blvd.
Suite 4
Fort Lauderdale FL 33308
(305) 461-1530**DELPHIC SOFTWARE SYSTEMS****Software** Program Development/Debugging225 South Sierra Avenue #25
Solano Beach CA 92075
(714) 755-6560**DELTA DATA SYSTEMS****Hardware** Microcomputers1953 Metropolitan Dr.
Tavares FL 32777
(313) 332-5400**THE DENVER SOFTWARE COMPANY****Software** Integrated Accounting, Professional Services14000 E Jewell Ave.
Suite 15
Aurora CO 80012
(303) 759-5960**DESIGN SOFTWARE****Software** Program Development/Debugging4227 E 11th St.
Tulsa OK 74104
(918) 661-5655

DESIGNER SOFTWARE**Software** Word Processing/Text Editing1400 Harrison Blvd.
Houston TX 77064
(713) 539-4221**DESIGNERS & BUILDERS OF INFORMATION SYSTEMS (DBIS)****Software** Accounts Payable, Accounts Receivable, Payroll/Personnel, Sales/Marketing, Professional Services, Word Processing/Text Editing, Data Base Management
One Mayfair Rd.
Bronxville NY 10520
(914) 739-1390**DESKTOP COMPUTER SOFTWARE****Software** Budgeting/Forecasting320 Powers St.
20100
Santa Clara CA 95051
(408) 428-9865**DIGICOMP RESEARCH****Hardware** Microcomputers, Add-in ModulesTomasz Hall
Ithaca NY 14850
(607) 273-1980**DIGILOG BUSINESS SYSTEMS****Hardware** MicrocomputersWalsh Rd & Park Dr.
PO Box 110
Montgomeryville PA 18936
(215) 628-4890**DIGITAL CONSTRUCTS****Software** Utilities130 Main Street,
Pittsford NY 14535
(716) 271-2632**DIGITAL DESIGN & DEVELOPMENT****Hardware** MicrocomputersPO Box 223
Stage St Industrial Park
Walpole MA 02081
(508) 661-1999**DIGITAL EQUIPMENT****Software** Budgeting/Forecasting**Hardware** Microcomputers146 Main Street
Maynard MA 01754
(508) 863-5111**DIGITAL LABORATORIES****Software** Microcomputers400 Pleasant St.
Weston MA 01889
(617) 874-1480**DIGITAL MARKETING****Software** Professional Services, Word Processing/Text Editing, Data Communications, Utilities, Program Development/Database2070 Cherry Lane
Walnut Creek CA 94596
(415) 539-3880**DIGITAL MICROSYSTEMS****Software** Manufacturing**Hardware** Microcomputers1000 Encino
Cupertino CA 95014
(415) 532-3888**DIGITAL RESEARCH****Software** Graphics, Operating Systems, Utilities, LanguagesPO Box 579
Pacific Coast CA 92660
(609) 449-3884**DISPLAY DATA****Hardware** MicrocomputersExecutive Plaza IV
Hunt Valley MD 21030
(301) 667-5715**DISTRIBUTED COMPUTER SYSTEMS****Hardware** Microcomputers333 Ormsby St
Waltham MA 02454
(508) 865-8111**DMA SYSTEMS****Hardware** Workstations101 Five Ave
Corte Madera CA 94921
(415) 450-3651**DONALD R. FREY & COMPANY****Software** Budgeting/Forecasting880 Alexandria Pkwy.
R. Thomas KY 41074
(502) 471-6266**DOTRONIX****Hardware** Display Monitors160 1st St. St.
New Brighton NY 10562
(914) 635-1742

DOW JONES

Software: Data Communications
PO Box 300
Princeton NJ 08540
(609) 427-5274

DP-TEK

Hardware: Printers
PO Box 3471
Wichita KS 67201
(316) 687-0276

DUAL SYSTEMS

Hardware: Microcomputers, Add-on Peripherals
2000 San Pablo Ave
Berkeley CA 94703
(415) 549-5854

DURANGO SYSTEMS

Hardware: Microcomputers
3030 N Rose St
San Jose CA 95134
(408) 945-5800

DYNABYTE

Hardware: Microcomputers
1211 Cedarwood Dr
Milpitas CA 95035
(408) 262-1221

DYNALOGIC INFO-TECH

Hardware: Microcomputers
8 Colonnade Rd
Oshawa, Ontario K1J 7M8
Canada
(905) 526-7711

**DYNAMIC MICROPROCESSOR
ASSOCIATES**

Software: Integrated Accounting, Data Generalization,
Utilities
505 Fifth Avenue
New York NY 10017
(212) 607-7772

DYNATEM

Hardware: Microcomputers
20400 C Laramie St
Suite 1007
El Segundo CA 90245
(310) 653-2223

E&L INSTRUMENTS

Hardware: Microcomputers
41 Pine St
Derby CT 06418
(203) 729-8774

E&U ENGEL CONSULTING

Hardware: Microcomputers
1719 S Cahuenga Ave
Los Angeles CA 90023
(310) 600-4271

EAGLE COMPUTER

Hardware: Microcomputers, Microchips
500 University Ave
Los Gatos CA 95030
(408) 359-5020

EAGLE SOFTWARE PUBLISHING

Software: Professional Services
99 Old Eagle School Road
Wayne PA 19087
(215) 644-8840

EATON PRINTER PRODUCTS

Hardware: Printers
Printer Products
Technical Research Park
Riverside NY 10511
(800) 824-4821

ECCOM ASSOCIATES

Software: Engineering/Scientific
8041 W. Brown Deer Road
Milwaukee WI 53224
(414) 354-0240

ECOSOFT

Software: Engineering/Scientific
PO Box 66600
Indianapolis IN 46268
(317) 233-6479

ECS MICROSYSTEMS

Hardware: Microcomputers
311 Devon Dr
San Jose CA 95112
(408) 286-4200

EF HASKELL & ASSOCIATES

Software: Integrated Accounting, Professional Services
1528 E Missouri
Suite A201
Phoenix AZ 85014
(602) 277-2234

EINSTEIN

Software: Word Processing/Text Editing, Languages
11048 W Olympic Blvd
Los Angeles CA 90064
(213) 477-4539

ILLIS COMPUTING

Software: Languages

3917 Horner St
San Francisco CA 94123
(415) 551-0384

INTEK SCIENTIFIC

Software: Engineering/Scientific

4460 Lake Forest Drive
Suite 700
Cincinnati OH 45242
(513) 563-7360

ENTERPRISE COMPUTER SYSTEM

Software: Professional Services

815 S Main, Suite C-14
PO Box 10396
Jacksonville FL 32207
(904) 734-1699

EPIC COMPUTER PRODUCTS

Software: Graphics

Hardware: Microcomputer, Workstation
10725 Eliza
Suite #1
Mountain Valley CA 95036
(714) 942-7999

EPS

Software: Budgeting/Forecasting

1188 Technology Dr
San Jose CA 95118
(408) 256-4912

EPSON AMERICA

Hardware: Microcomputer, Printers

3495 Kehlers St
Torrance CA 90505
(213) 514-7140

ESCAPE COMPUTER SOFTWARE

Software: Graphics

PO Box 1771
Roswell GA 30075
(404) 577-5345

ESP COMPUTER RESOURCES

Software: Data Base Management

9 Ash Street
Hollis NH 03049
(603) 462-7244

EUROPEAN AMERICAN BANK

10 Hanover Square
New York NY 10035
(212) 429-4300

EVENTION

Software: Add-on Memory

385 W 54th St
New York NY 10019
(212) 841-4700

EVOTEK

Hardware: Workstation

1229 Page Ave
Fremont CA 94536
(415) 493-3100

EXALIBER TECHNOLOGIES

Software: Languages

800 Rio Grande Blvd
Nanaimo BC
V9R 5W6
(604) 242-3333

EXECUCOM SYSTEMS

Software: Budgeting/Forecasting

3400 Fairview Blvd
Austin TX 78731
(512) 346-4990

EXHIDY

Hardware: Microcomputer

395 Java Dr
Sunnyvale CA 94088
(408) 734-5888

EZ SOFTWARE

Software: Utilities

PO Box 591
Menlo Park CA 94036
(415) 366-8238

FARMLAND COMPUTER SYSTEMS

Software: Professional Services

1980 Sunnyvale Sanitized Rd
Sunnyvale CA 94087
(408) 734-8226

FETTI SYSTEMS & SOFTWARE

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Job Costing, Sales/Inventory, Professional Services, Manufacturing

204 Main St
Dallas Park PA 15110
(412) 762-8260

FIBOX MICROSYSTEMS

Software: Budgeting/Forecasting, Graphics, Data Communications

1701 N 11th St
Suite 400
Arlington VA 22209
(703) 541-0880

FERRANTI COMPUTER SYSTEMS LTD

Hardware: Microcomputers

Sinclair Way,
Wythenshawe
Manchester
England M22 5LA
Telephone: 061-999-1022

FIRST SOFTWARE

Software: Data Communications

5422 E. Paseo
Scottsdale AZ 85254
(602) 951-1238

FORETHOUGHT PRODUCTS

Hardware: Microcomputers, Add-on Memories

87075 Dulichuber Rd
Tucson AZ 85722
(602) 469-5573

FORTH

Software: Operating Systems

2300 Pacific Coast Hwy.
Huntington Beach CA 92649
(714) 321-8863

FORTUNE SYSTEMS

Hardware: Microcomputers

1301 Industrial Rd
San Carlos CA 94070
(415) 591-4944

FOX & GELLER

Software: Graphics, Program Development/Testing

PO Box 1023
Tewksbury MA 01886
(508) 821-0142

FRANKLIN COMPUTER

Hardware: Microcomputers, Diskettes

2000 Colonial Highway
Pembroke Pines 33069
(305) 489-1700

FRIDAY BUSINESS SYSTEMS

20120 Seagull Way
Lancaster CA 93536
(408) 553-5259

FRIENDS SOFTWARE

Software: Data Base Management

PO Box 127
Reddick GA 31070
(404) 540-7282

FRONTIER SOFTWARE

Software: Utilities

714 Bowring Green
Orlando FL 32805
(407) 736-8240

FUJITSU

Hardware: Microcomputers, Printers

3000 Scott Blvd.
Santa Clara CA 95051
(408) 720-6700

FUTURE COMPUTERS LTD

Hardware: Microcomputers

PO Box 204
Farnham, Surrey
England
Telephone: 01483-041

G. L. INTERSIL SYSTEMS

Hardware: Add-on Memories

1375 Hanoverwood Ave.
Sunnyvale CA 94086
(408) 743-8442

GANDALF DATA

Hardware: Modems

1011 S. Noel Ave.
Wheeling IL 60090-3807
(312) 549-4940

GENERAL DATACOMM INDUSTRIES

Hardware: Modems

One Kennedy Ave.
Danbury CT 06810
(203) 749-2711

GENERAL DIGITAL INDUSTRIES

Hardware: Microcomputers

500 Myer Dr.
Mountain View CA 94031
(415) 967-1800

GENERAL ELECTRIC

Hardware: Printers

General Electric Drive
Waynesboro VA 22980
(540) 469-3175

GENERAL ROBOTICS

Hardware: Add-on Memories

52 N. Main St.
Marlboro NJ 07747
(908) 423-8800

GENERAL SYSTEMS SCIENCES

Software: Data/Database

621 Union Street Rd
Altamonte Springs Fl 32719
(305) 869-1457

GEOGRAPHIX

Software: Graphics

156 N Third St
Philadelphia PA 19106
(215) 529-4800

GIFFORD COMPUTER SYSTEMS

Hardware: Microcomputers

1922 Republic Ave
San Jose CA 95127
(408) 299-0758

GIMIX

Hardware: Microcomputers

1217 W 37th Place
Chicago IL 60609
(312) 527-5210

GMR

Hardware: Microcomputers

1648 E 8th Street
Covina CA 91724
(714) 497-4440

GMS SYSTEMS

Software: Data Base Management

12 W 37th St
New York NY 10018
(212) 947-2550

GOLDEN STATE BUSINESS SYSTEMS

Software: Engineering/Scientific

1940 F Street
Sacramento CA 95814
(916) 441-2917

GOULD

19800 Research Ave
Cupertino CA 95014
(408) 259-6200

GRAPHIC COMMUNICATIONS

Software: Graphics

200 Thirteenth Ave
Waltham MA 02454
(617) 893-4278

GRAPHIC SOFTWARE SYSTEMS

Software: Engineering/Scientific

15117 SW Parkway
PO Box 473
Wilsonville OR 97070
(503) 632-1408

GRAPHICS SOFTWARE

Software: Graphics

1972 Massachusetts Ave
Cambridge MA 02140
(617) 490-2454

GREAT PLAINS SOFTWARE

Software: Integrated Accounting

121 N 18th
Omaha NE 68102
(402) 390-8480

GRID SYSTEMS

Software: Graphics

Hardware: Microcomputers

2625 Campus Ave
Mountain View CA 94031
(415) 961-6000

GROUNDSTAR SOFTWARE

Software: Accounts Payable, Accounts Receivable, General Ledger, Payroll/Personnel, Integrated Accounting, Sales/Order Entry, Budgeting/Forecasting, Data Base Management

10220 S DeAnza Blvd
Suite 300
Cupertino CA 95014
(408) 448-3402

GRUNDY BUSINESS SYSTEMS LTD

Hardware: Microcomputers

Grundy House
Somerset Rd
Reddington, Middlesex
England TW11 8TO
Telephone 01-977-1171

GTCO

Software: Graphics

1000 Park St
Rockville MD 20850
(301) 279-6650

GTE LENKURT

Hardware: Modems

1105 County Rd
San Carlos CA 94070
(415) 595-3600

H&H SCIENTIFIC

Software Professional Services

15801 Pendleton St.
Suite 300B/300C/300D
Brentwood, CA 94513
(415) 279-2650

HARVARD SOFTWARE

Software Publishing/Reselling

Harvard MA 01451
(617) 486-4202

HAWKEYE CRANIX

Software Data Communications

20914 Mobile St.
Carmel Park CA 91307
(213) 348-7905

HAYDEN BOOK

Software Word Processing/Text Editing

50 Davis St.
Buchanan Park NJ 07005
(201) 840-0350

HAYDEN SOFTWARE

**Software Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales Distribution**

4000 Suffolk
Lowell MA 01852
(508) 452-4230
(508) 453-1218

**HAYES MICROCOMPUTER
PRODUCTS**

Software Data Communications

Hardware Modems

3800 Peachtree Center E.
Norcross GA 30071
(404) 449-5771

THE HEADLANDS PRESS

Software Data Communications

PO Box 862
Tiburon CA 94580
(415) 429-5075

HEATH

Hardware Printers

PO Box 496
Boston Harbor MA 02122
(617) 560-3000

HEICON

Hardware Printers

PO Box 247
31 Park Road
Wilton Falls HI 07774
(201) 342-1000

HEURONIC

Hardware Address Meters

3001 Latham Dr.
Madison WI 53703
(608) 271-8700

HEWLETT-PACKARD

**Software Professional Services, Engineering/Research
Hardware Microcomputer, Workstation, Calculators,
Printers, Modems**

1507 Page Mill Rd.
Palo Alto CA 94304
(415) 861-4400
(800) 747-7701

HFK SOFTWARE

Software Word Processing/Text Editing

Old Canterbury Rd.
PO Box 110
Danbury CT 06810
(203) 744-2888

HI-G PRINTER PRODUCTS

Hardware Printers

100 Spring St.
Wimberley TX 78676
(512) 423-3343

**HIGH TECHNOLOGY SOFTWARE
PRODUCTS**

Software Manufacturing

PO Box 65498
1511 NW 25th St.
Oklahoma City OK 73104
(405) 524-4259

HIGLEY & CO

Software Payroll/Personnel

PO Box 491
Marion OH 44640
(216) 744-5259

HOLIDAY SOFTWARE

Software Data Base Management, Utilities

4807 Adeline Street
San Diego CA 92117
(714) 261-7754

**HONEYWELL INFORMATION
SYSTEMS**

Hardware Microcomputers

300 Smith St.
William MA 02154
(508) 559-5000

HORIZON SOFTWARE SYSTEMS

Software Word Processing/Text Editing

265 Berry St.
San Francisco CA 94107
(415) 540-1199

OURGLASS SYSTEMS

Software: Budgeting/Forecasting

PO Box 312
Cinn. Hwy 11, 60137
(319) 459-1850**HOWARD SOFTWARE SERVICES**

Software: Professional Services

8000 Grand Avenue
Suite 210
La Jolla CA 92037
(619) 454-0121**HUMAN ENGINEERED SOFTWARE**

Software: Graphics, Word Processing/Text Editing

71 Park Ln
Suisun CA 94503
(707) 468-6110**HUMAN SYSTEMS DYNAMICS**

Software: Budgeting/Forecasting, Graphics

5249 Fremont Blvd Suite 107
Pleasanton CA 94564
(415) 453-9536**HUNTER & READY**

Software: Operating Systems

440 Sherman Ave
Iolo Alto CA 94036
(415) 328-0960**IBM**

Software: Operating Systems, Data Communication

Hardware: Microcomputers

1103 Winchester Ave
White Plains NY 10604
(914) 684-1820**ICL COMPUTERS**

Hardware: Microcomputers

North American Operations
401 E Airport Freeway
Irving TX 75062
(214) 258-8525**ICOT**

Hardware: Modems

800 Marullo Ave
Mountain View CA 94034
(415) 964-4033**IDE ASSOCIATES**

Hardware: All-in Micros

44 Main St
Burlington MA 01803
(617) 223-7340**IE SYSTEMS**

Software: Data Communication

38 Main St
Newmarket NH 03857
(603) 659-9871**ING**

Software: Word Processing/Text Editing

1240 W Foothill Blvd
Upland CA 91786
(714) 946-5428
(714) 943-7327**IMS INTERNATIONAL**

Hardware: Microcomputers

2000 Lockheed Way
Carmel City NY 10020
(718) 663-7611**INCOM SYSTEMS**

Software: Professional Services

5013 Sandpoint Way NE
Seattle WA 98115
(206) 527-8888**INFO DESIGNS**Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Inventory600 Telegraph Rd
Birmingham MI 48001
(313) 843-4810**INFORMATION BUILDERS**

Software: Data Base Management

1200 Broadway
New York NY 10001
(212) 736-9433**THE INFORMATION PEOPLE**

Software: Program Development/Debugging

442 Huron Ave
Newark OH 43055
(614) 349-8644**INFORMATION UNLIMITED SOFTWARE (IUS)**Software: Accounts Payable, Accounts Receivable,
General Ledger, Integrated Accounting,
Sales/Inventory, Budgeting/Forecasting,
Word Processing/Text Editing, Data Base
Management2421 Mainship Way
Newville CA 95657
(408) 371-4030

INFOSCRIBE

Software: Printers

2720 S Credit Way
Santa Ana CA 92706
(714) 841-6975

INFOTEC'S

Software: Microcomputers

One Perimeter Rd
Manchester NH 03103
(603) 623-2700

INFO-TEK

Software: Utilities, Add-on Modules

1480 N Foster St
Anaheim CA 92806
(714) 734-5000

INFOTRON SYSTEMS

Software: Utilities

Cherry Hill Industrial Center
Cherry Hill NJ 08002
(609) 424-9400

INNOVATIVE SOFTWARE

Software: Graphics, Data Base Management

1920 W 11th St
Suite 300
Overland Park KS 66210
(913) 383-1600

INNOVATIVE COMPUTER SYSTEMS & SOFTWARE

1801 Highland Road
Silver Spring MD 20904
(301) 584-0207

INNOVATIVE SOFTWARE ASSOCIATES

Software: Professional Services

80 Wall Street
New York NY 10006
(212) 423-5186

INSOFT

Software: Integrated Accounting, Data Base Management, Languages

10111 SW Barber Blvd
Suite 3000
Portland OR 97219
(503) 224-4130

INSTANT SOFTWARE

Software: Publishing/Networking

Pearlborough NH 03461
(603) 934-5471

INSTRUMENTATION LABORATORY

Software: Microcomputers

Post Office
One Barn Rd
Andover MA 01810
(617) 479-1070

INTEGRAL DATA SYSTEMS

Software: Printers

101 13th
Milford NH 03046
(603) 673-7700

INTEGRATED BUSINESS COMPUTERS

Software: Microcomputers

10000 S Wilmington Ave
Mo 356
Carmel CA 93618
(209) 336-4240

INTEGREX

Software: Printers

201 N Juniper St
Philadelphia PA 19102
(215) 565-5681

INTEL

Software: Operating Systems

Software: Microcomputers
3945 Bowen
Santa Clara CA 95051
(408) 967-4000

INTELLIGENT SYSTEMS

Software: Microcomputers

221 Technology Pl
Hayward CA 94541
(415) 449-0581

INTERACTIVE PICTURE SYSTEMS

Software: Graphics

270 Park Ave South
New York NY 10010
(212) 421-5888

INTERACTIVE SYSTEMS TECHNOLOGY

Software: Microcomputers

5258 N Tropicana Ave
Suite 11
Las Vegas NV 89129
(702) 259-1760

INTERNATIONAL DATA PROCESSING

Software: Professional Services

74 Roland Ave.
Montgomery NY 12549
(518) 846-5009

INTERNATIONAL MARKET RESOURCES

Software: Sales/Distribution

301 Gardner Rd.
Westbury NY 11590
(516) 231-8800

INTERNATIONAL MEMORIES

Hardware: Microcomputers

10201 Bandley Dr.
Cupertino CA 95014
(408) 946-1777

INTERNATIONAL MICRO SYSTEMS (IMS)

Software: Accounts Payable, Accounts Receivable, General Ledger, Financials/Invoicing, Job Costing, Integrated Accounting, Sales/Distribution, Professional Services, Word Processing/Text Editing

6405 Mission
Shawnee Mission KS 66202
(913) 677-1107

INTERTEC DATA SYSTEMS

Hardware: Microcomputers

2300 Broad River Rd.
Columbia SC 29209
(803) 798-9000

INTERTECHNIQUE

Hardware: Microcomputers

26070 Plaza
France
Telephone: (305) 423-0000

THE IPAC GROUP

Hardware: Microcomputers

PO Box 156
3017 Industrial Ave.
Bethel Park PA 15102
(412) 781-5000

IRWIN OLIVETTI

Hardware: Microcomputers

2000 Cypress Rd.
Ann Arbor MI 48108
(313) 663-3000

ISE

Software: Program Development/Debugging, Languages

350 W Superior Hwy.
West Lafayette IN 47906
(317) 492-4555

ITHACA INTERSYSTEMS

Hardware: Microcomputers, Add-in Modules

1600 Franklin Rd.
Rheem NY 14850
(607) 231-0190

JERSEY MICRO SYSTEMS

Software: Integrated Accounting, Professional Services

12000 Rockfield Road
Cherry Hill NJ 08002
(609) 424-2555

JINI MICRO-SYSTEMS

Software: Data Base Management

Box 274
Brookline MA 02446
(617) 736-4200

JOHNSON ASSOCIATES

Software: Utilities

PO Box 2601
Redding CA 96049-2601
(916) 251-0740

JRT SYSTEMS

Software: Languages

500 Irving St.
San Francisco CA 94110
(415) 564-5100

KAYCOMP COMPUTERS

Hardware: Microcomputers

550 Stevens Ave.
Solana Beach CA 92075
(714) 755-1334

KAYE INSTRUMENTS

Hardware: Printers

15 DeAngelo Dr.
Rockford IL 61102
(815) 275-0300

KELIX SOFTWARE SYSTEMS

Software: Engineering/Scientific

429 Discovery Drive
Baton Rouge LA 70802
(314) 766-4755

KENSINGTON MICROWARE

Software: Word Processing/Text Editing

511 Third Ave.
New York NY 10017
(212) 484-7707

KEUFFEL & ESSER:

Hardware: Microcomputers

1000 Jones Malterreger Rd.
San Antonio TX 78211
(512) 422-4232

KEY SOFTWARE

Software: Data Base Management

2150 E. Division Ave.
Den Haan IL 60016
(312) 299-3610

KEY SYSTEMS

Software: Manufacturing

PO Box 1371
Matthews NC 28106
(704) 243-1400

LAND INNOVATION

Software: Engineering/Scientific

PO Box 10602
Dallas TX 75230-0602
(414) 224-5540

LEXISOFT

Software: Word Processing/Text Editing

PO Box 267
Davis CA 95616
(916) 752-3630

LIFEBOAT ASSOCIATES

Software: Publishing/Processing, Engineering/Scientific,

Word Processing/Text Editing, Operating
Systems, Utilities, Program

Development/Debugging, Languages

1011 Third Avenue
New York NY 10028
(212) 882-0300

LIFETREE SOFTWARE

Software: Word Processing/Text Editing

177 Webster
Suite 342
Montgomery AL 36104
(334) 429-1531

LINBERGH SYSTEMS

Software: Data Communications

41 Franklin Rd.
Holden MA 01520
(508) 863-4223

LINK SYSTEMS

Software: Data Communications

1440 19th Street
Santa Monica CA 90404
(213) 453-1851

LJK ENTERPRISES

Software: Data Base Management

PO Box 10027
St. Louis MO 63129
(314) 962-1655

LNW COMPUTERS

Hardware: Microcomputers

2620 Walnut Ave.
Tustin CA 92680
(714) 544-1244

LOGICA

Software: Data Communications

616 Third Ave 19th Floor
New York NY 10017
(212) 599-0828

LOGICAL SYSTEMSSoftware: Word Processing/Text Editing, Operating
Systems, Utilities

1100 N. Post Washington Rd.
Madison WI 53703
(414) 248-2044

LOTUS DEVELOPMENT

Software: Publishing/Processing, Graphics

101 Five St.
Cambridge MA 02142
(617) 450-7071

LOVELLS

Software: Data Communications

4225 Illinois
Cottage Grove IL 60411
(312) 852-3098

M HODIS & ASSOCIATES

Software: Engineering/Scientific

1980 Professional Drive
Santa Clara CA 95051
(408) 542-5750

M/A-COM OFFICE SYSTEMS

Hardware: Microcomputers

7 Oak Park
Bedford MA 01730
(617) 279-4442

MAD COMPUTER

Software: Microcomputer

1210 South Blvd Suite 10
Santa Clara, CA 95051
(408) 960-0640

MADWEST SOFTWARE

Software: Graphics

PO Box 9023
Madison WI 53705
(608) 238-8875

MAIL/BASIC FOUR

Hardware: Microcomputer

Information Systems Div
11601 Myford Rd
Tustin CA 92680
(714) 731-5100

MANAGEMENT & COMPUTER SERVICES

Software: Budgeting/Forecasting

Great Valley Corporate Center
Valley Forge PA 19482
(215) 649-0730

MANNESMANN TALLY

Hardware: Printers

6001 S 160th St
Kenosha WI 53140
(414) 271-5000

MANX SOFTWARE SYSTEMS

Software: Languages

PO Box 55
Stroudsburg PA 18301
(215) 759-4500

MAP SYSTEMS

Software: Utilities

1120 NASA Road One
Suite 444
Houston TX 77038
(713) 520-5540

MARC SOFTWARE INTERNATIONAL

Software: Word Processing/Text Editing

280 Sheldon Avenue
Suite 200
Palo Alto CA 94301
(415) 321-1971

MARK OF THE UNICORN

Software: Word Processing/Text Editing

PO Box 403
Arlington VA 22214
(703) 489-1387

MARKETING ESSENTIALS

Software: Program Development/Debugging

205 Webster Avenue
Westwood NY 10590
(800) 643-2622

MAJETEC INTERNATIONAL ELECTRONICS

Hardware: Microcomputer

20 Williams St
Wellesley MA 02181
(617) 227-2115

MATROX ELECTRONIC SYSTEMS

Hardware: Microcomputer, Add-on Memories

8880 Anjou Ave
T.M.E. Montreal H4T 1H4
Canada
(514) 738-1762

MOC SOFTWARE

Software: Sales/Distribution, Budgeting/Forecasting, Professional Services, Word Processing/Text Editing

3729 Morris Hwy 40
PO Box 180
Johnson IA 50131
(515) 271-3387

MCCLINTOCK

Software: Professional Services

1601 South Dixie Hwy
PO Box 400880
Miami FL 33160
(305) 946-1100

DANN MOOREARY SOFTWARE

Software: Data Communication

PO Box 16405
San Diego CA 92116
(714) 747-5011

MOCULLOUGH & ASSOCIATES

Software: Manufacturing

1420 N. Jessie James Rd
Brooker Springs MO 64024
(816) 621-6636

MOM COMPUTERS

Hardware: Microcomputer

131 Dalton St
Kingston ON K7L 4W2
Canada
(905) 344-9880

MCMILLAN COMPUTING SERVICES

Software: Program Development/Debugging
PO Box 62
Reading RG1 5AE
England
(073) 441-4291

MEMODYNE

Hardware: Printers
230 Reservoir St.
Needham Heights, MA 02194
(617) 446-7800

MEMOREX

Hardware: Printers
San Tomas & Central Driveway
Santa Clara CA 95051
(408) 967-1600

MERCATOR BUSINESS SYSTEMS

Hardware: Microcomputers
1294 Lawrence Station Rd
Sunnyvale CA 94089
(408) 734-5134

METASOFT

Software: Word Processing/Text Editing
1714 E Coltonwood
Suite 6
Casa Grande AZ 85223
(602) 834-6268

MICRO APPLICATIONS GROUP

Software: Data Base Management, Utilities
3020 Sherman Way
Suite 200
Canoga Park CA 91306
(213) 782-1426

MICRO BUSINESS SOFTWARE (MBSI)

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution
Dover Rd
Willow Hill Bldg.
Chichester BN1 3DN
(024) 759-5700

MICRO BUSINESS SYSTEMS

Software: Professional Services, Manufacturing
7725 Broadway
Suite 2
Nashville TN 37210
(615) 740-3445

MICRO CONTROL SYSTEMS

Software: Graphics
141 Tintall Rd
Weston CT 06083
(203) 873-0488

MICRO DATA BASE SYSTEMS

Software: Data Base Management
1225 3rd Avenue
PO Box 248
Lafayette LA 70504
(318) 489-1036

MICRO DATA BUSINESS FORMS & SYSTEMS

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel, Job Costing,
Integrated Accounting, Sales/Distribution,
Professional Services
1207 Lacey Blvd
#104
Olympia WA 98502
(360) 459-3300

MICRO FIVE

Hardware: microcomputers
1770 Sky Park Circle
Irvine CA 92714
(714) 257-1217

MICRO FOCUS

Software: Program Development/Debugging
1401 Civic Center Dr
Santa Clara CA 95034
(408) 248-3984

MICRO MANUFACTURING SYSTEMS

Software: Manufacturing
101 Shagbark
Westerville OH 43081
(614) 865-0738

MICRO METRIC

Software: Word Processing/Text Editing
102 E St
No 20
Dana CA 95434
(916) 758-8333

MICRO PERIPHERALS

Hardware: Microdrives, Diskette
1754 Dooling Ave
Chatsworth CA 91311
(818) 769-4293

MICRO SOURCE

Software: Microcomputers

PO Box 2119
New Haven CT 06540
(203) 567-1252

MICRO SYSTEMS SOFTWARE

Software: Data Communications

4001-18 Old Circle
Beaumont TX 77401
(281) 985-1590

MICRO TECHNOLOGY

Software: Utilities

1100-C Knott's Ave
Orange CA 92667
(714) 771-1942

MICRO TECHNOLOGY UNLIMITED

Software: Microcomputers

PO Box 17704
2800 Hillsborough St
Raleigh NC 27603
(919) 830-1498

MICRO-SCI

Software: Utilities

2150 S Hawthorne St
Santa Ana CA 92706
(714) 731-1981

MICRO-WARE DISTRIBUTORS

Software: Graphics

PO Box 113
Pembroke Pines FL 33064
(305) 859-5678

MICROAPI LTD.

Software: Microcomputers

19 Catherine Pl
Victoria, London
England SW11 4DX
Telephone: 01-634-2667/8

MICROBAR SYSTEMS

Software: Microcomputers

1100 San Antonio Rd
Palo Alto CA 94303
(415) 964-2942

MICROCOM

Software: Data Communications

1450 A Providence Hwy
Roxbury MA 02142
(617) 742-1010

MICROCOMPUTER CONSULTANTSSoftware: Account Payable, Accounts Receivable,
General Ledger, Sales/Distribution

PO Box 1377
Davis CA 95617
(916) 756-9162 (outside CA)
(707) 536-8704 (inside CA)

MICROCOMPUTER SYSTEMS

Software: Utilities

401 Lakeside Dr
San Jose CA 95138
(408) 733-4239

MICROMATION LTD

Software: Word Processing/Text Editing

1 Yorkdale Rd
Suite 404
Toronto Ontario M4S 1A1
Canada

MICROMOTION

Software: Graphics

1207 Melville Blvd
Suite 308
Los Angeles CA 90025
(213) 631-4340

MICROPERIPHERAL

Software: Modems

2500 113rd Ave NE
Redmond WA 98052
(206) 851-7544

MICROPOLIS

Software: Utilities

2029 Hawthorne St
Chatsworth CA 91311
(213) 769-3330

MICROPRO INTERNATIONALSoftware: Budgeting/Forecasting, Graphics, Word
Processing/Text Editing, Data Base
Management, Utilities

30 San Pablo Ave
San Rafael CA 94903
(415) 479-1200

MICROPROCESSOR SYSTEMS

Software: Filters

215 Canfield Dr
Avalon FL 32531
(305) 634-2363

MICROSOFT

Software: Spreading/Repeating, Word Processing/Text Editing, Operating Systems, Languages
Hardware: Add-on Monitors
16015 Northup Way
Redmond WA 98052
(206) 823-6000

MICROSTUFF

Software: Data Communications
1900 Leland Drive
Suite 12
Menlo Park CA 94025
(415) 923-0267

MICROTECH BUSINESS SYSTEMS

Hardware: Microcomputers
3140 Tuolumne St.
Corte Madera CA 94926
(707) 568-5640

MICROTECH EXPORTS

Software: Utilities
407 Hamilton Avenue
Suite 2
Palo Alto CA 94301
(415) 324-9714

MICROTEK

Hardware: Add-on Monitors
9214 Chesapeake Dr.
San Diego CA 92121
(714) 278-8620

MIDWEST COMPUTER CENTER

Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Human Resources, Job Costing,
Manufacturing
3785 Marie May Road
Johnson City 17701
(706) 276-0367

MILES COMPUTING

Software: Financials
7036 Hazelton Ave.
Van Nuys CA 91406
(213) 769-4207

MILLER MICROCOMPUTER SERVICES

Software: Languages
40 Lake Shore Rd.
Haverhill MA 01841
(617) 652-4736

MINISCRIBE

Hardware: Microcomputers
4701 18th Street
Longmont CO 80501
(303) 461-6000

MISOSYS

Software: Graphics, Utilities, Program Development/Debugging
2904 Edgewood Dr.
Alexandria VA 22303
(703) 960-2990

MOLECULAR COMPUTER

Software: Data Base Management
Hardware: Microcomputers
1840 Barker Rd.
San Jose CA 95112
(408) 988-1440

MORPHOLITHIC SYSTEMS

Hardware: Add-on Monitors
4 Inverness Circle East
Englewood CO 80112
(303) 770-7400

MONROE SYSTEMS

Software: Data Communications
Hardware: Microcomputers
The American Rd.
Morristown NJ 07960
(201) 540-7300

MORGAN-FAIRFIELD GRAPHICS

Software: Graphics
4224-A University Way Rd.
Seattle WA 98103
(206) 632-1274

MORROW DESIGNS

Hardware: Microcomputers, Add-on Monitors
15201 Central Ave.
Richardson TX 75244
(915) 634-2100

MOTOROLA

Hardware: Microcomputers
Box 22812
3000 E. McDowell Rd.
Phoenix AZ 85020
(602) 344-5730

MPC PERIPHERALS

Hardware: Add-on Monitors
9401 Chesapeake Dr.
San Diego CA 92121
(714) 279-8620

MPS COMPANY

Software: Graphics/Scientific

8 North Grant Drive
Addison IL 60101
(708) 443-1748

MPSI (MICROCOBOL PRODUCTS)

Software: Access, Recordable, Word Processing/Text

Editing, Operating Systems, Languages
2471 E Bayshore Rd
Suite 340
Palo Alto CA 94303
(415) 856-3282

MULTI-TECH SYSTEMS

Hardware: Microcomputers, Modems

82 Second Ave St
New Brighton MN 55112
(612) 671-1990

MULTISOFT

Software: Graphics

14025 JW Farmington Rd
Beaverton OR 97005
(503) 623-4770

MULTISOFT

Software: Data Base Management

120 E 40th St
New York NY 10016
(212) 334-8800

MULTITECH ELECTRONICS

Hardware: Microcomputers

185 W 8th St
San Jose CA 95102
(408) 777-8800

MUSE SOFTWARE

Software: Word Processing/Text Editing

347 Hi Charter St
Baltimore MD 21201
(301) 459-7312

MYCROFT LABS

Software: Data Communications

PO Box 4400
Tallahassee FL 32301
(904) 365-2508

NATIONAL SEMICONDUCTOR

Hardware: Microcomputers

2900 Semiconductor Dr
Santa Clara CA 95051
(408) 737-5000

NCR

Hardware: Microcomputers

1200 S Patterson Blvd
Dayton OH 45409
(513) 443-3075

NBC INFORMATION SYSTEMS

Hardware: Microcomputers, Modems

5 Abbott Dr
Lexington MA 02129
(510) 862-2130

NEPTUNE PROGRAMS

Software: Sales/Distribution

44 Third Ave
Suite F
Corte Madera CA 94926
(415) 423-1487

NESTAR SYSTEMS

Software: Budgeting/Forecasting, Data Communications

Hardware: Microcomputers

2345 E Bayshore Rd
Palo Alto CA 94303
(415) 493-2223

NEW WORLD COMPUTER

Hardware: Microcomputers

2176 Fullerton St
Suite 120
Costa Mesa CA 92626
(714) 536-5323

NF SYSTEMS

Software: Data Communications

PO Box 7080
Atlanta GA 30356
(404) 362-1300

NNC ELECTRONICS

Hardware: Microcomputers

1500 Computer Lane
Huntington Beach CA 92646
(714) 859-8000

NÖRDELL DATA SYSTEMS

Software: Word Processing/Text Editing

2400 Wilshire Blvd
Los Angeles CA 90006
(213) 257-3026

NORTH AMERICA MICA

Software: Budgeting/Forecasting

11772 Sorrento Valley Rd
San Diego CA 92121
(714) 451-6950

NORTH STAR COMPUTERS

Software: Microcomputers

14440 Calleira Street
San Leandro CA 94577
(415) 222-4200

NORTHERN TELECOM

Software: Microcomputers

P.O. Box 1222
Minneapolis MN 55440
(612) 522-6276

NORTHWEST ANALYTICAL

Software: Budgeting/Forecasting

1322 SW Morrison St.
Portland OR 97201
(800) 224-7727

NOVATION

Hardware: Modems

38405 Franklin St.
Chatsworth CA 91311
(213) 888-5080

NU DATA

Hardware: Modems

33 Fairview Ave.
Little Silver NJ 07740
(201) 842-1737

NUMERITRONIX

Hardware: Microcomputers

2580 Aspinwall Circle
Newbury Park CA 91300
(800) 499-2842

OASIS SYSTEMS

Software: Word Processing/Text Editing

1365 Raymond Way
San Diego CA 92148
(714) 271-9489

OCCUPATIONAL COMPUTING COMPANY (OCC)

Software: General Ledger, Payroll/Personnel, Integrated Accounting, Professional Services

22011 Ventura Blvd.
Suite 123
Woodland Hills CA 91364
(800) 325-1999

OHIO DATA BASE

Software: Professional Services, Word Processing/Text Editing

4422 W. 21st St.
No. 1
Cleveland OH 44119
(216) 523-5000

OKIDATA

Hardware: Printers

101 Caliber Dr.
Alt. Laurel HI 80024
(800) 329-3800

OUVETTI

Hardware: Microcomputers, Printers

152 White Plains Rd.
Tarrytown NY 10591
(800) 421-6100

OLYMPIA USA

Hardware: Microcomputers, Printers

P.O. Box 22
P.O. Box 22
Somerville NJ 08876
(201) 712-7800

OLYMPIC SYSTEMS

Software: Manufacturing

110 Melody Ave.
Santa Rosa CA 95403
(707) 529-1291

OLYMPUS SOFTWARE

Software: Budgeting/Forecasting

544 Elizabeth St.
Salt Lake City UT 84102
(800) 363-5202

OMEGA MICROWARE

Hardware: Add-on Memory

222 S. Riverside Plaza
Chicago IL 60606
(312) 449-1624

OMICRON SOFTWARE

Software: Graphics

Suite 200, Bldg. 17
Executive Pk. 300
Milpitas CA 95035
(408) 253-0124

OMNIBYTE

Hardware: Microcomputers

240 W. Roosevelt Rd.
Bldg. 1 Unit 1
West Chicago IL 60185
(708) 221-4480

OMNITRIC DATA

Hardware: Modems

2405 S. 20th St.
Phoenix AZ 85024
(602) 263-5223

ONTOOL

Software: Languages

212 Beacon St
Wellesley MA 02454
(617) 869-7030

ON-LINE INSTRUMENT SYSTEMS

Software: Engineering/Scientific

Route 2
Box 2784
Jefferson GA 30549
(804) 367-9771

ONTEL

Software: Word Processing/Text Editing

Hardware: Microcomputers

200 Greenway Park Dr
Woodbury NY 11797
(516) 364-3221

ONYX SYSTEMS

Software: Languages

Hardware: Microcomputers

73-8 Hinckley Rd
San Jose CA 95131
(408) 946-4200

OPEN SYSTEMS

Software: Accounts Payable, Accounts Receivable,

General Ledger, Payroll/Personnel, Job Costing,
Manufacturing

420 Oak Grove
Suite 400
Minneapolis MN 55400
(612) 870-2015

OSBORNE COMPUTER

Hardware: Microcomputers

28800 Corporate Ave
Hayward CA 94541
(415) 867-8000

OSBORNE/MCGRAW HILL

Software: Budgeting/Forecasting

610 Broadway Way
Berkeley CA 94710
(415) 546-2005

OSM COMPUTER

Hardware: Microcomputers

2964 Welch Ave
Santa Clara CA 95051
(408) 241-8710

OTRONIA

Hardware: Microcomputers

4050 Walnut St
Boulder CO 80301
(303) 444-8120

OWL SOFTWARE

Software: Word Processing/Text Editing

1927 Alcott Ave
North Hollywood CA 91405
(213) 863-4241

PACSOFT

Software: Engineering/Scientific

723 Seventh Ave
Kirkland WA 98033
(206) 827-0551

PANASONIC

Software: Utilities

Hardware: Microcomputers, Printers

One Panasonic Way
Secaucus NJ 07094
(201) 346-7700

PARAMETRICS

Software: Engineering/Scientific

1121 W Oak
St. Collins CO 80321
(303) 321-3740

PASCAL SYSTEMS

Software: Case File Management

620 Merito Ave
Suite 100
Merito Plz CA 94021
(415) 321-0761

PEACHTREE SOFTWARE

Software: Accounts Payable, Accounts Receivable,

General Ledger, Payroll/Personnel,

Sales/Ordering, Budgeting/Forecasting,

Deposits, Word Processing/Text Editing

2448 Peachtree Rd NE
Atlanta GA 30306
(404) 262-1276

PEBX

Hardware: Add-on Modules

501 Mandell Way
Campbell CA 95028
(408) 361-7000

PEGASUS DATA SYSTEMS

Hardware: Microcomputers

234 Lockland Dr
Middleton NJ 08846
(302) 646-6707

PERFECT SOFTWARE

Software: Budgeting/Forecasting, Word Processing/Text

Editing, Case File Management

1400 Marbrook Ave
Bethesda MD 20850
(301) 844-3324

PERICOMP SYSTEMS

Software: Accounts Payable, Accounts Receivable, Integrated Accounting, Sales/Distribution
7000 Dr
Natick MA 01760
(508) 651-2460

PERKIN-ELMER

Hardware: Microcomputers
2 Greenway Pl
Norwalk CT 06851
(203) 850-4712

PERSONAL MICRO COMPUTERS

Hardware: Microcomputers, Displays
473 Ellis Street
Mountain View CA 94030
(415) 962-0200

PERTIC COMPUTER

Hardware: Microcomputers
17332 Von Karman Ave
PO Box 11800
Irvine CA 92714
(714) 540-8240

PHASE ONE SYSTEMS

Software: Billing/Programming, General Utilities
2705 Edgewater Dr
Suite 880
Oakland CA 94621
(415) 542-8025

PHC

Hardware: Microcomputers
PO Box 1108
21 Westy Dr
Ann Arbor MI 48106
(313) 994-0501

PHILADELPHIA CONSULTING GROUP

Software: Data Communications
PO Box 162
wynnewood PA 19090
(215) 649-1598

PHILIPS DATA SYSTEMS

Hardware: Microcomputers
PO Box 246
Apeldoorn
The Netherlands
Telephone (050-320123)

PK SYSTEMS

Software: Professional Services
102 N. Center St.
Bloomington IL 61701
(309) 242-9431

PLENARY SYSTEMS

Hardware: Microcomputers
9669 Woodell Rd
Dallas TX 75241
(714) 941-9881

PLESSEY MICROSYSTEMS

Hardware: Microcomputers, Add-on Modules
417 Plungertree Dr
Rockville MD 20850
(301) 279-2892

PLESSEY PERIPHERAL SYSTEMS COMPUTER PRODUCTS DIV

Hardware: Add-on Modules
1024 McCabe Ave
Irvine CA 92714
(714) 862-9885

POINT 4 DATA

Software: Operating Systems
Hardware: Microcomputers
1000 McCabe Way
Irvine CA 92714
(714) 862-9111

POLARIS MICROCOMPUTERS

Hardware: Microcomputers
1050 Herbst Ave
Van Nuys CA 91408
(213) 888-5111

PRACTICAL AUTOMATION

Hardware: Printers
Prop. Kelly Rd
Shelton CT 06484
(203) 929-5281

PRECISION VISUALS

Software: Graphics
1000 Lookout Rd
Boulder CO 80301
(303) 590-9000

PREDIX

Software: Data Communications
1303 Avenue of the Americas
New York NY 10019
(212) 577-9890

PRENTICE

Hardware: Modems
206 Cypress Dr
Sunnyvale CA 94086
(408) 734-9878

PRINTER PRODUCTS**Software: Printers**

18 Derby St.
Allston MA 02134
(617) 787-0280

PRINTERS SOFTWARE**Software: Sales/Distribution**

990 Route 29 South
Paramus Park NJ 07652
(201) 629-5757

PRODIGY SYSTEMS**Software: Accounts Receivable, Payroll/Personnel**

407 Lincoln Hwy
Media PA 19063
(215) 569-2523

PRODUCT ASSOCIATES**Software: Microcomputer**

400 Convention Way
Redwood City CA 94063
(415) 364-3221

PROFESSIONAL BUSINESS COMPUTER SYSTEMS**Software: Sales/Distribution, Manufacturing**

10215 N. Scottsdale Road
Scottsdale AZ 85255
(602) 948-5772

PROFESSIONAL COMPUTER SERVICES**Software: Professional Services**

534 Cooke St.
Honolulu HI 96813
(808) 367-5062

PROFESSIONAL SOFTWARE**Software: Professional Services, Word Processing/Text Editing**

10 Franklin St.
Needham MA 02494
(617) 444-5224

PROGRAMMED SYSTEMS**Software: Professional Services**

10 Rugby Dr.
Suite 305
Birmingham AL 35209
(205) 928-4126

PYRAMID DATA LTD**Software: Budgeting/Forecasting**

PO Box 10116
Santa Ana CA 92711
(714) 755-1527

QANTEX**Hardware: Printers**

40 Plant Ave.
Hauppauge NY 11788-3960
(516) 480-4260

QUADRAM**Hardware: Add-on Memories**

4007 Park Dr.
Norcross GA 30092
(404) 921-4666

QUANTUM**Software: Winchester**

1804 McCarthy Blvd.
Milpitas CA 95035
(408) 262-1180

QUANTUM COMPUTER SYSTEMS LTD**Hardware: Microcomputers**

40-62 The Balsam, Meriden Castle
Leyton
England LS2 8HQ
Telephone 0532 458877

QUARK ENGINEERING**Software: Word Processing/Text Editing**

1420 Williams
Suite 1100
Denver CO 80218
(303) 734-2211

QUASAR DATA PRODUCTS**Hardware: Microcomputers**

10200 Brookville Rd.
Cleveland OH 44132
(216) 523-0288

QUASITRONICS**Hardware: Add-on Memories**

211 Windale Dr.
Houston TX 77040
(713) 745-3963

QUAY**Hardware: Microcomputers**

227 Industrial Way W
PO Box 789
Dateland WA 98324
(206) 546-7340

QUELO**Software: Program Development/Debugging**

140 Hwy 146
Seattle WA 98137
(206) 784-6811

R&B COMPUTER SYSTEMS

Software Professional Services

108 South Oliver Drive
Tempe AZ 85281
(602) 964-7900

R&L SOFTWARE

Software Engineering/Scientific

1290 Beacon Street
Newton MA 02161
(617) 964-0992

RABBIT SOFTWARE

Software Data Communications

1 Great Valley Pkwy East
Malvern PA 19355
(215) 442-0440

RACAL-DANA

Hardware Modems

4 Chelmsford St. 02114
PO Box C-19540
Irvine CA 92713
(714) 850-8799

RACAL-WADIC

Hardware Modems

221 Casper Dr.
Santa Clara CA 95051-5074
(408) 744-8992

RAINBOW COMPUTING

Software Graphics

15517 Business Center Dr.
Montebello CA 90214
(310) 639-6200
(310) 629-9887

RAIR

Hardware Microcomputers

4101 Burton Dr.
Santa Clara CA 95051
(408) 968-1780

RAIR LTD

Hardware Microcomputers

6-8 Upper St. Martin's Ln.
London
England WC1H 0BQ
Telephone: 01-403-4421

REALWORLD SOFTWARE

Software Word Processing/Text Editing

911 South Federal St.
Suite 100
Olympia WA 98512
(360) 756-4476

REDDING GROUP

Software Graphics

601 Main St.
Bridgewater CT 06820
(203) 451-8841

REGENCY SYSTEMS

Hardware Microcomputers

PO Box 3500
1800 Innovation Dr.
Champaign IL 61820
(217) 356-8862

RELATIONAL SYSTEMS**INTERNATIONAL**

Software Utilities, Program Development/Debugging

PO Box 12892
Salmon Creek WA 98374
(800) 343-6829

REMEX

Software Engineering/Scientific

Remex Solutions
4000 35th St. N.
Suite A
Grand Rapids MI 49503
(616) 452-8880

RESTON PUBLISHING

Software Graphics

11401 Sunset Hills Rd.
Reston VA 20190
(703) 422-8800

RIVON

Hardware Modems

2120 Industrial Pkwy.
Silver Spring MD 20904
(301) 662-2121

RODIME

Hardware Workstations

2401 Ohare
Suite 6
Arlington Hts IL 60106
(708) 579-3055

ROTATING MEMORY SYSTEMS

Hardware Workstations

1701 McCarthy Blvd.
Milpitas CA 95035
(408) 948-8820

RYAN-MCFARLAND

Software Languages

429 Deep Valley Dr.
Rolling Hills Estates CA 90274
(310) 341-4820

R2E OF AMERICA

Software: Microcomputers

2940 W County Rd C
Roseville MN 55113
(612) 438-5900

SAICE COMPUTER TECHNOLOGY

Software: Microcomputers

4901 Avenue Way
Brentwood NY 11717
(516) 322-6888

SANYO BUSINESS SYSTEMS

Software: Microcomputers, Printers

25 Joseph St.
Mahwah NJ 07430
(201) 440-5300

SATELLITE SOFTWARE INTERNATIONAL

Software: Word Processing/Text Editing

388 W Center St.
Orem UT 84057
(800) 224-6254

SATURN SYSTEMS

Software: Budgeting/Forecasting

Hardware: Add-in Memories

PO Box 8060
Ann Arbor MI 48107
(313) 973-6622

SBCC & EUCO SYSTEMS

Software: Professional Services, Manufacturing

13342 Sunset Place
Santa Ana CA 92705
(714) 751-6550

SCENIC COMPUTER SYSTEMS

Software: Word Processing/Text Editing

Hardware: Microcomputers

14821 Rd 11a Circle
Redmond WA 98052
(206) 855-2580

SCI SYSTEMS

Hardware: Microcomputers

5000 Technology Drive
PO Box 1000
Huntington Park 90637
(310) 832-4800

SCI-COM COMPUTER SYSTEMS

Hardware: Microcomputers

994 Rte 22
PO Box 4050
Bridgewater NJ 08807
(201) 682-0970

SCIENTIFIC DATA SYSTEMS

Software: Microcomputers

341 Main Street
Menlo Park CA 94025
(415) 362-8873

SCIENTIFIC MICRO SYSTEMS

Hardware: Microcomputers, Diskettes

777 E Middlefield Rd
Mountain View CA 94030
(415) 964-3760

SD SYSTEMS

Hardware: Microcomputers

1011 Miller Rd
PO Box 38610
Dallas TX 75230
(214) 340-0003

SEAGATE TECHNOLOGY

Hardware: Winchester

380 E. Fremont St.
Scotts Valley CA 95066
(408) 438-4200

SEATTLE COMPUTER PRODUCTS

Hardware: Microcomputers, Add-in Memories

1114 University Dr
Seattle WA 98101
(206) 525-1820

SEQUA COMPUTER

Hardware: Microcomputers

205 West St.
Annapolis MD 21401
(301) 268-4850

SELAHAR

Software: Graphics

407-Aida Ave
Santa Clara CA 95080
(408) 732-2811

SELECT INFORMATION SERVICES

Software: Word Processing/Text Editing

905 1/2 Francis Drake Blvd
Kenfield CA 93004
(415) 465-4000

SELVA SYSTEMS

Software: Graphics

147 Worcester St.
Wellesley MA 02481
(617) 421-7576

SEMDISK SYSTEMS

Software: Address Mailing
PO Box 540
Beaverton OR 97075
(503) 642-3100

SENDERO

Software: Financial Services
400 N 14th St
Phoenix AZ 85004
(602) 279-5400

SENTINEL COMPUTER

Software: Utilities
9002 Center Rd
Cincinnati OH 45242
(513) 984-6622

SHAFER & SHAFER APPLIED RESEARCH & DEVELOPMENT

Software: Budgeting/Forecasting
3460 N High St
Columbus OH 43214
(614) 262-3100

SHAKTI SYSTEMS

Software: Data Base Management
PO Box 34540
Schaumburg IL 60141
(312) 888-0811

SHARP ELECTRONICS

Software: Applications
10 Kaymarie Rd
Flemington NJ 08822
(201) 232-0680

SHUGART

Software: Utilities
403 Oakmead Pkwy
Sunnyvale CA 94086
(408) 733-0130

SIERRA NATIONAL

Software: Applications
1007 Software St
San Diego CA 92111
(714) 277-4810

SIERRA ON-LINE

Software: Word Processing/Test Editing
Sierra On-Line Building
Cupertino CA 95014
(408) 482-6888

SILICON VALLEY

Software: Word Processing/Test Editing
1625 El Camino Real #4
Mountain View CA 94031
(415) 964-4444

SIMULATED COMPUTER PRODUCTS

Software: Word Processing/Test Editing
4011 N 19th Street Blvd
Tucson AZ 85713
(602) 742-1091

SINCLAIR OPTICS

Software: Engineering/Scientific
20 N Main Street
Westford MA 01884
(781) 261-0100

SINCLAIR RESEARCH

Software: Mathematics
Sunnyslope Rd
Columbus OH 43228
(614) 865-0711

SINGLE SOURCE SOLUTION

Software: Professional Services
2099 Clayton Rd
Cupertino CA 95014
(408) 480-0322

SMALL BUSINESS SYSTEMS GROUP

Software: Sales/Distribution, Data Communications
8 Central Road
Westford MA 01884
(508) 861-1800

THE SMALL COMPUTER

Software: Data Base Management
40 W Ridgewood Ave
Englewood NJ 07632
(201) 442-5840

SMALL RECORDS ASSOCIATES

Software: Utilities
PO Box 50
Ukiah CA 95427
(707) 759-5237

SMC SOFTWARE SYSTEMS

Software: Operating Systems, Languages
1001 Route 23
PO Box 1620
Englewood NJ 07632
(201) 442-5000

SMITH-CORONA**Software: Printers**

Consumer Products Div
69 Lovers Ave
New Canaan CT 06840
(203) 961-1671

SMOKE SIGNAL BROADCASTING

Software: Budgeting/Forecasting
Hardware: Microcomputers, Add-in Options
10206 Via Colinas
Woodland Village CA 91364
(213) 889-0240

SO/STAR

Software: Budgeting/Forecasting
13155 US Hwy 411
Lure Beach FL 32408
(305) 422-8811

SOFSYS

Software: Word Processing/Text Editing
4201 Union Ave S
Minneapolis MN 55400
(612) 122-7794

SOFTCORP INTERNATIONAL

Software: Budgeting/Forecasting
219 Huber Village Blvd
Waynesville OH 45081
(513) 889-3820

SOFTTEAM

Software: Budgeting/Forecasting
10000 W Jefferson Blvd
Culver City CA 90230
(310) 421-0814

SOFTTECH MICROSYSTEMS

Software: Operating Systems, Languages
10005 W Bernardo Dr
San Diego CA 92121
(619) 451-1280

SOFTTEST

Software: Word Processing/Text Editing
950 College Rd
Edgewood NJ 07020
(201) 447-3821

SOFTRONICS

Software: Data Communications
1628 Prince Edward
Memphis TN 38119
(901) 753-5806

SOFTWARE ARTS**Software: Budgeting/Forecasting**

27 Main Line
Wellesley MA 02481
(508) 227-4020

SOFTWARE CONNECTIONS

Software: Data Communications
1800 Wynd Dr
Suite 17
Santa Clara CA 95051
(408) 748-3794

SOFTWARE DEVELOPMENT

Software: Utilities
210 Avenir Rd
Woodbridge CT 06525
(203) 287-0500

SOFTWARE DYNAMICS

Software: Word Processing/Text Editing
2117 W Crescent
Suite C
Anaheim CA 92801
(714) 423-4710

THE SOFTWARE EXPRESS

Software: Accounts Receivable
10101 Fondren
Suite 200
Houston TX 77090
(281) 231-0082

THE SOFTWARE GROUP

Software: Program Development/Orchestrating
10071 S Brookhurst St
Anaheim CA 92804
(714) 523-5274

SOFTWARE HOWS

Software: Professional Services
PO Box 34275
Los Angeles CA 90034
(213) 459-4671

SOFTWARE LIBRARIES

Software: Word Processing/Text Editing
PO Box 864
Pasadena CA 91102
(213) 793-1760

SOFTWARE MODULE MARKETING

Software: Data Communications
Crocker Bank Building/Foothouse
1007 Seventh St
Sacramento CA 95814
(916) 444-6012

SOFTWARE PRODUCTS INTERNATIONAL

Software: Accounts Receivable, Integrated Accounting, Budgeting/Forecasting, Professional Services, Data Base Management
10340 Roselle St
Suite A
San Diego CA 92121
(714) 450-1526

SOFTWARE PUBLISHING

Software: Graphics, Word Processing/Text Editing, Data Base Management
1000 Landings Dr
Mountain View CA 94030
(415) 962-6700

SOFTWARE RESOURCES

Software: Budgeting/Forecasting, Professional Services, Graphics
100 Alewife Brook Parkway
Suite 310
Cambridge MA 02138
(617) 492-9800

SOFTWARE SORCERY

Software: Data Communications
7007 James Branch Dr
Suite 400
McLean VA 22102
(703) 265-2904

SOFTWARE SYSTEMS

Software: Word Processing/Text Editing
53 Oakland Ave N
East Hartford CT 06108
(800) 322-2114

THE SOFTWARE TOOLWORKS

Software: Budgeting/Forecasting, Word Processing/Text Editing
14076 Glendale Drive
Sherman CA 95403
(707) 858-0704

SOLZBERG RESEARCH ASSOCIATES

Software: Manufacturing
3 Seabrook Court
Stony Brook NY 11790
(516) 731-4277

SONY

Hardware: Microcomputer
Microcomputer Products Division
7 Memphis Dr
Norwell MA 02043
(508) 875-6999

SORCIM

Software: Budgeting/Forecasting
405 Alida Dr
Santa Clara CA 95051
(408) 252-7624

SORD COMPUTER OF AMERICA

Software: Graphics
Hardware: Microcomputer
300 Park Ave
New York NY 10164
(212) 631-4400

SOUTHEASTERN SOFTWARE

Software: Data Communications
4474 Derbyshire Drive
New Orleans LA 70136
(504) 248-8438

SOUTHWEST SYSTEMS

Software: Account Payable, Account Receivable,
General Ledger, Payroll/Personnel, Job Costing,
Integrated Accounting
44 Third Ave
Suite 2
Culver City CA 90230
(310) 423-5500

SOUTHWESTERN DATA SYSTEMS

Software: Data Communications
PO Box 562
Sausalito CA 94967
(415) 362-3670

SPECIAL DELIVERY SOFTWARE

Software: Budgeting/Forecasting, Professional Services
10200 Bandley Dr
Cupertino CA 95014
(408) 254-1070

SPECTRA/SOFT

Software: Professional Services
PO Box 277
Chandler AZ 85224
(602) 963-6380

SSM MICROCOMPUTER

Software: Data Communications
Hardware: Address Memories
2150 Paragon Dr
San Jose CA 95131
(408) 946-2400

SSR CORP

Software: Data Distributions
1480 Lyell Avenue
Redwood City CA 94083
(415) 324-3228

STAR COMPUTER GROUP

Software: Word Processing/Text Editing

PO Box 321
Stevens Pt. 14546
(412) 964-3711

STAR MICRONICS

Hardware: Printers

200 Park Ave.
Pan Am Building Suite 2000
New York, NY 10166
(212) 596-6770

STAR SOFTWARE SYSTEMS

Software: Integrated Accounting

29400 Camino Real
Torrance CA 90507
(310) 528-2511

STAR VALUE SOFTWARE

Software: Professional Services

12118 Schiller Dr.
Austin, TX 78759
(512) 457-9456

STARSOFT

Software: Professional Services

4064 El Camino Real
Suite 120
San Mateo CA 94403
(415) 965-8009

STATE OF THE ARTSoftware: Accounts Payable, General Ledger,
Payroll/Financial, Sales/Inventory

3511-A Alvarado Avenue
Casa Mesa CA 92626-4458
(714) 830-8713

STELLATION TWO

Hardware: Microprocessors

Libbey Blvd.
PO Box 2342
Santa Barbara CA 93120
(805) 966-7140

STM ELECTRONICS

Hardware: Microcomputers

520 Middlefield Rd.
Suite 120
Menlo Park CA 94025
(415) 929-4029

STOK SOFTWARE

17 West 17th Street
New York, NY 10011
(212) 334-1444

STONEWARE

Software: Graphics, Data Base Management

50 Belvedere St.
San Rafael CA 94901
(415) 459-8838

STRUCTURAL PROGRAMMING

Software: Graphics

40 Systems Park Rd.
Sudbury MA 01776
(508) 441-3384

STRUCTURED SYSTEMS GROUP (SSG)Software: Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Financial,
Sales/Inventory, Budgeting/Forecasting,
Word Processing/Text Editing, Data Base
Management, Utilities

5201 Clayson Ave.
Oakland CA 94618
(415) 549-1967

STSC

Software: Languages

2115 E. Jefferson St.
Rockville MD 20850
(301) 961-6200

SUNBELT COMPUTER SYSTEMS

Sunbelt Center
2400 Park St. Steet
Tulsa OK 74102
(918) 742-0726
(800) 331-9168

SUPERSOFTSoftware: Budgeting/Forecasting, Word Processing/Text
Editing, Data Base Management, Data
Communication, Utilities, Program
Development/Debugging, Languages

PO Box 9428
Champaign IL 61820
(217) 352-2112

SYKES DATATRONICS

Hardware: Microprocessors

155 E Main St.
Rochester NY 14604
(716) 325-8000

SYNAPSE SOFTWARE

Software: Utilities

600 Coventry Road
Kensington CA 94707
(415) 527-7733

SYQUEST TECHNOLOGY**Software:** Winchester

81160 Main Springs Blvd
Pleasanton CA 94568
(415) 450-7231

**SYSTEM INTEGRATION
ASSOCIATES****Software:** Sales/Distribution, Professional Services,
Operating Systems

Suite 1-13 Great Valley Center
81 Lancaster Avenue
Malvern PA 19355
(215) 594-7400

SYSTEMS GROUP**Software:** Add-in Modules

1001 Coorswood Ave
Orange CA 92666
(714) 632-4480

SYSTEMS PLUS**Software:** Accounts Payable, Accounts Receivable,
General Ledger, Integrated Accounting,
Sales/Distribution, Budgeting/Forecasting,
Professional Services, Data Base Management

1120 San Antonio Rd
Palo Alto CA 94303
(415) 865-7647

THE SYSTEMS SHOPPE**Software:** Professional Services

104 E Main St
Greenwood MO 64044
(314) 837-7827

TAB PRODUCTS**Software:** Microcomputers

1401 California Ave
Palo Alto CA 94304
(415) 865-2000

TALLGRASS TECHNOLOGIES**Software:** Winchester

9207 Cody
Overland Park KS 66211
(913) 467-1988

TANDATA**Software:** Microcomputers

2004 E 32nd St
Suite 6
Tulsa OK 74103
(918) 747-3271

TANDON**Software:** Workstation, Database

2000 Park St
Chatsworth CA 91311
(818) 983-2424

TANDY (RADIO SHACK)**Software:** Budgeting/Forecasting, Professional Services,
Engineering/Scientific, Graphics, Word
Processing/Text Editing, Operating Systems,
Data Base Management, Utilities**Hardware:** Microcomputers, Printers

1800 One Tandy Center
Fort Worth TX 76102
(800) 550-1320

TARANTO & ASSOCIATES**Software:** Accounts Payable, Accounts Receivable,
General Ledger, Integrated Accounting,
Sales/Distribution

121 Paul Dr
San Ramon CA 94583
(415) 423-3470

TARBELL ELECTRONICS**Software:** Data Base Management**Hardware:** Microcomputers

160 Oxford Place
Suite B
Carmel CA 93723
(800) 548-0211

TCS SOFTWARE**Software:** Accounts Payable, Accounts Receivable,
General Ledger, Payroll/Personnel,
Sales/Distribution, Professional Services,
Manufacturing, Data Base Management

3399 Fondren Rd
Houston TX 77043
(713) 937-1925

TEAC**Software:** Diskette

2750 Telegraph Rd
Mountain View CA 94034
(415) 736-0808

TECHNICAL DATA**Software:** Professional Services

1 Festival St
Boston MA 02108
(617) 482-3445

**TECHNICAL SYSTEMS
CONSULTANTS**

111 Providence Rd
Chapel Hill NC 27514
(919) 489-1451

TECHAS

Hardware: Add-on Memories

23600 Merchantile Rd
Cleveland OH 44123
(216) 464-7400

TEX-COM

Hardware: Modems

7142 Paragon Dr
San Jose CA 95131
(408) 263-7400

TEKTRONIX

Hardware: Microcomputers

PO Box 500
4110 SW Karl Braun Dr
Beaverton OR 97077
(503) 644-6111

TELEPHONE SOFTWARE CONNECTION

Software: Data Communications

PO Box 1048
Danville CA 94526
(209) 576-1900

TELERAM COMMUNICATIONS

Hardware: Microcomputers

2 Corporate Park Dr
White Plains NY 10604
(914) 474-6270

TELETEK

Hardware: Add-on Memories

9102 F Business Park Dr
Sacramento CA 95827
(916) 361-1771

TELEVIDEO SYSTEMS

Software: Publishing/Presenting

Hardware: Microcomputers

1170 Mission Ave
Santa Clara CA 95034
(408) 746-0780

TENSEGREGITY

Software: Engineering/Scientific

3104 W Addison St
Chicago IL 60618
(312) 528-5714

TERAK

Hardware: Microcomputers

14901 N 26th St
Scottsdale AZ 85260
(602) 958-4800

TEXAS ELECTRONIC INSTRUMENTS

Software: Data Base Management

5075 S Loop 610
Houston TX 77060
(713) 779-2300

TEXAS INSTRUMENTS

Software: Utilities

Hardware: Microcomputers, Minicomputers

PO Box 2909
Austin TX 78769
(512) 260-7111

TEXASOFT

Software: Languages

3111 Wisconsin Ave
Suite 100
Dallas TX 75219
(214) 846-0791

TEXPRINT

Hardware: Printers

8 Blanchard Rd
Burlington MA 01803
(617) 271-1084

THE LWTW GROUP

Software: Professional Services

12900 Park Central
Suite 1000
Dallas TX 75251
(214) 223-5381

THOMAN SOFTWARE (TSC)

Software: Professional Services

1821 Summit Rd
Suite 107
Cincinnati OH 45227
(513) 548-5700

THOUGHTWARE PUBLISHING

Software: Accounting/Finance

PO Box 461
Circus Park OH 45326
(513) 476-1467

3M

Hardware: Windshields

Business Communications Products
Div
3M Center
St Paul MN 55103
(612) 730-8572

THREE RIVERS COMPUTER

Hardware: Microcomputers

720 Cross St
Pittsburgh PA 15224
(412) 627-6200

THRESHOLD SOFTWARE

Johnson Engineering/Scientific

1002 Tribune Rd
Suite 2
Sacramento CA 95814
(916) 923-6185

TIMBERLINE SOFTWARE

Software: Accounts Payable, Accounts Receivable,

General Ledger, Payroll/Personnel,

Banking/Investing

P.O. Box 25428
Portland OR 97228
(503) 643-9441

TIMEPLEX

Hardware: Modems

400 Chestnut Ridge Rd
Woodcliffe Lakes NJ 07675
(201) 591-1111

TIPNIS

Software: Manufacturing

10005 Indigo Dr
Cincinnati OH 45241
(513) 791-3805

TMS/MSC

Software: Professional Services

2110 South 1270 West
Salt Lake City UT 84119
(801) 523-2800

TMW

Hardware: Modems

3444 Encinitas St
San Diego CA 92110
(619) 266-2110

TORCH COMPUTERS LTD

Hardware: Microcomputers

Abbeytree House
Great Shelford Cambridge
England CB25 0JQ
Telephone: (0223) 304000

TOSHIBA AMERICA

Hardware: Microcomputers

2441 Michelle Dr
Santa CA 93060
(714) 732-9200

TRAC LINE SOFTWARE

Software: Accounts Payable, Sales/Distribution,
Budgeting/Forecasting, Professional Services,
Manufacturing, Data Base Management

91 Alpha Plaza
Rockville MD 20850
(301) 885-7500

**TRENDATA/STANDARD
MEMORIES**

Hardware: Address Memories

3400 W. Sepulveda Ave.
Santa Ana CA 92704
(714) 542-9625

TRENDCOM/3M

Hardware: Printers

4800 Oakmead Parkway
Sunnyvale CA 94088
(408) 733-4947

TRI-DATA

Hardware: Modems

305 E. Middlefield Rd
Mountain View CA 94031
(415) 969-2780

TRIVECTOR COMMERCE LTD

Hardware: Microcomputers

Sunderland Rd
South, Bedfordshire
England SG19 1BB
Telephone: 44 767 82222

TRONWARE

Software: Word Processing/Text Editing

3809 W. 16th St.
Overland Park KS 66201
(913) 381-0176

TRW-FUJITSU

Hardware: Microcomputers

1641 Alpen Blvd
Los Angeles CA 90041
(213) 642-4798

TUCK ELECTRONICS

Hardware: Modems

330 3rd St
New Cumberland PA 17040
(717) 770-4834

TYMSHARE

Software: Printers

2000 Valley Green Rd
Cupertino CA 95014
(408) 446-6000

U.S. ROBOTICS

Hardware: Modems

1120 W Washington
Chicago IL 60607
(312) 731-0000

UNIQUE INFORMATION SYSTEMS

Software: Professional Services, Engineering/Scientific

220 N LaSalle St
Suite 1220
Chicago IL 60601
(312) 332-2800

UNITED PERIPHERALS

Hardware: Displays

402 Lakeside Dr
San Jose CA 95136
(408) 730-4440

UNIVERSAL DATA SYSTEMS

Hardware: Modems

3020 Bradford Dr
Huntsville AL 35803
(334) 557-8100

UNIVON COMPUTER SYSTEMS

Software: Data Base Management

899 Logan St
Denver CO 80203
(303) 291-7817

VANDATA

Software: Integrated Accounting

10104 Neurville Ave N
Suite 107
Seattle WA 98133
(206) 466-5146
(206) 542-7801

VECTOR GRAPHIC

Software: Integrated Accounting, Budgeting/Forecasting, Graphics, Word Processing/Text Editing, Data Base Management, Data Communications

Hardware: Microcomputers, Printers

500 N Vassar Park Rd
Thousand Oaks CA 91320
(805) 499-5801

VEN-TEL

Hardware: Modems

2342 High St
Santa Clara CA 95051
(408) 727-5721

VIA COMPUTER

Software: Budgeting/Forecasting

7107 Constitution St
San Diego CA 92121
(619) 537-1436

VICTOR BUSINESS PRODUCTS

Software: Word Processing/Text Editing

Hardware: Microcomputers

3600 N Broadway St
Chicago IL 60613
(312) 539-6200

VICTORY COMPUTER SYSTEMS

Hardware: Microcomputers

2015 Gateway Pk
Suite 300
San Jose CA 95110
(408) 264-4800

VIETHMANN

Software: Manufacturing

274 Main St
Reading PA 19607
(404) 544-5787

VILKAITUS CONSULTANTS

Software: Word Processing/Text Editing

417 High Street Rd
Thomaston CT 06487
(203) 356-4032

VISICORP

Software: Job Costing, Budgeting/Forecasting, Professional Services, Graphics, Word Processing/Text Editing, Data Communications, Utilities

3960 Zanker Road
San Jose CA 95114
(408) 948-8000

VISIONARY ELECTRONICS

Hardware: Modems

141 Parker Ave
San Francisco CA 94118
(415) 751-8811

VISTA COMPUTER

Hardware: Displays

1311 N Ellinger Ave
Santa Ana CA 92705
(714) 953-0521

VM PERSONAL COMPUTING

Software: Data Communications

60 E 42nd St
New York NY 10016
(212) 637-4707

WOLITION SYSTEMS

PO Box 1336
Del Mar CA
(760) 431-3288

WANG LABORATORIES

Hardware: Microcomputers
One Industrial Ave
Lowell MA 01851
(508) 429-5200

WAVE MATE

Hardware: Microcomputers
14001 S. Crenshaw Blvd
Rancho Cucamonga CA 91730
(213) 979-8600

WESTERN DIGITAL

Hardware: Microcomputers
2445 Aliso Creek Rd
Irvine CA 92714
(714) 557-3350

WESTERN DYNEX

Hardware: Minicomputers
3116 W. Calleon Rd
Phoenix AZ 85075
(602) 269-6401

WESTERN ELECTRIC

Software: Operating Systems
PO Box 25000
Carmel Valley NC 27010
(714) 957-2000

**WESTERN SOFTWARE
DEVELOPMENT**

Software: Word Processing/Text Editing
PO Box 1623
Woodland Park CO 80860
(303) 667-2517

WESTICO

Software: Systech Applications, Data Communications
29 Van Zandt St
Newark NJ 07105
(201) 463-6880

WESTMINSTER SOFTWARE

Software: Budgeting/Forecasting
3000 Sand Hill Rd
Bldg 4 Suite 300
Menlo Park CA 94025
(415) 524-1400

WHITESMITHS LTD

Software: Operating Systems, Languages
19 Lowell Rd
Concord MA 01742
(508) 369-6660

WICAT SYSTEMS

Software: Budgeting/Forecasting, Word Processing/Test
Editing, Operating Systems

Hardware: Microcomputers
PO Box 575
1075 S State
Orem UT 84057
(801) 224-4600

WINTEK

Hardware: Microcomputers
1501 South St
Lubbock TX 79404
(214) 340-6421

WPL ASSOCIATES

Software: Professional Services
1100 Spring Street
Suite 102
Silver Spring MD 20910
(301) 589-6261

XCOMP

Hardware: Microchips
7964 Trade St
San Diego CA 92121
(714) 271-6700

XEDEX

Hardware: Address Memories
330 St St
Suffolk NY 11781
(516) 368-0233

XEROX

Hardware: Microcomputers
1301 W. Martinbird Ln
Dallas TX 75247
(214) 632-2621

XYCOM

Hardware: Microcomputers
790 N. Maple Rd
Salem OR 97304
(503) 581-6571

XYLOGICS

Hardware: Microcomputers
144 Middlesex Turnpike
Burlington MA 01803
(617) 271-6140

**ZEDA COMPUTERS
INTERNATIONAL****Matthew Microsystems**1602 W. 63rd St.
Fresno, CA 93707
(805) 277-9544**ZENITH DATA SYSTEMS****Software: Word Processing/Text Editing, Data
Communications****Hardware: Microcomputers, Workstations, Displays,
Printers, Display Monitors**1000 Milwaukee Ave.
Champaign, IL 60625
(312) 391-8111**ZENTEC****Matthew Microsystems**2400 Walsh Ave.
Santa Clara, CA 95051
(408) 727-7662**ZILOG****Matthew Microsystems**10440 Bubb Ave.
Cupertino, CA 95014
(408) 256-4666



Product Specific Vendor Directory



PRODUCT SPECIFIC VENDOR DIRECTORY

APPLICATIONS SOFTWARE

Accounts Payable

American Business Systems

ASK Micro

Burroughs

CYMA

Data Base Research

Designers & Builders of
Information Systems (DBIS)

Felth Systems & Software

Groundstar Software

Hayden Software

Info Designs

Information Unlimited Software
(IUS)

International Micro Systems (IMS)

Micro Business Software (MBSI)

Micro Data Business Forms &
Systems

Microcomputer Consultants

Midwest Computer Center

Open Systems

- Peachtree Software

Pericom Systems

Southwest Systems

State of the Art

Structured Systems Group (SSG)

Systems Plus

Taranto & Associates

TCS Software

Thoughtware Publishing

Timberline Software

Trac Line Software

Accounts Receivable

American Business Systems

ASK Micro

Bristol Information Systems

Burroughs

Compugraphic

Continental Software

CYMA

Data Base Research

Data General

Designers & Builders of
Information Systems (DBIS)

Felth Systems & Software

Groundstar Software

Hayden Software

Info Designs

Information Unlimited Software
(IUS)

International Micro Systems (IMS)

Micro Business Software (MBSI)

Micro Data Business Forms &
Systems

Microcomputer Consultants

Midwest Computer Center

MPSI (Microbial Products)

Open Systems

- Peachtree Software

Pericom Systems

Prodigy Systems

The Software Express

Software Products International

Southwest Systems

Structured Systems Group (SSG)

Systems Plus

Taranto & Associates

TCS Software

Timberline Software

General Ledger

American Business Systems

ASK Micro

Burroughs

Construction Data Control

Continental Software

CYMA

Data Base Research

Felth Systems & Software

Groundstar Software

Hayden Software

Info Designs

Information Unlimited Software
(IUS)

International Micro Systems (IMS)

Micro Business Software (MBSI)

Micro Data Business Forms &
Systems

Microcomputer Consultants

Midwest Computer Center

Occupational Computing Company
(OCC)

APPLICATIONS SOFTWARE (Cont)

Open Systems	Midwest Computer Center
Peachtree Software	Open Systems
Southwest Systems	Southwest Systems
State of the Art	VisiCorp
Structured Systems Group (SSG)	Integrated Accounting
Systems Plus	Accountants Microsystems
Taranto & Associates	Alexander Grant & Co
TCS Software	Argos Software
Timberline Software	ASK Micro
Payroll/Personnel	BPI Systems
Accountants Microsystems	Construction Data Control
American Business Systems	CYMA
ASK Micro	The Denver Software Company
Bristol Information Systems	Dynamic Microprocessor
Burroughs	Associates
Computer Products	EF Haskell & Associates
Construction Data Control	Great Plains Software
CYMA	Groundstar Software
Data Base Research	Information Unlimited Software
Designers & Builders of	(IUS)
Information Systems (DBIS)	Insoft
Felt Systems & Software	International Micro Systems (IMS)
Groundstar Software	Jersey Micro Systems
Hayden Software	Micro Data Business Forms &
Higley & Co	Systems
Info Designs	Occupational Computing Company
International Micro Systems (IMS)	(OCC)
Micro Business Software (MBS)	Pericom Systems
Micro Data Business Forms &	Software Products International
Systems	Southwest Systems
Midwest Computer Center	Star Software Systems
Miles Computing	Systems Plus
Occupational Computing Company	Taranto & Associates
(OCC)	Vandata
Open Systems	Vector Graphic
Peachtree Software	Sales/Distribution
Prodigy Systems	Acme Software
Southwest Systems	American Business Systems
State of the Art	ASK Micro
Structured Systems Group (SSG)	B-Squared
TCS Software	Bristol Information Systems
Timberline Software	Burroughs
Job Costing	Computerax
Argos Software	Data Base Research
Computer Options	Data General
Construction Data Control	Designers & Builders of
Felt Systems & Software	Information Systems (DBIS)
International Micro Systems (IMS)	Felt Systems & Software
Micro Data Business Forms &	General Systems Sciences
Systems	Groundstar Software

APPLICATIONS SOFTWARE (Cont.)

Information Unlimited Software (IUS)
 International Market Resources
 International Micro Systems (IMS)
 MCC Software
 Micro Business Software (MBS)
 Micro Data Business Forms & Systems
 Microcomputer Consultants
 Mepatha Programs
 Open Systems
 Peachtree Software
 Pericomp Systems
 Printers Software
 Professional Business Computer Systems
 Small Business Systems Group
 SSR Corp
 State of the Art
 Structured Systems Group (SSG)
 System Integration Associates
 Systems Plus
 Taranto & Associates
 TCS Software
 Trac Line Software

Budgeting/Forecasting:
 Access Technology
 Addison-Wesley Publishing
 Advanced Management Strategies
 Action-Tel
 Automated Insurance Rating Services
 Business Planning Systems
 Business Solutions
 Cheng Laboratories
 Computer Marketing Services
 Comshare
 Comshare Target Software
 Control Management Systems
 Dakid
 Desktop Computer Software
 Digital Equipment
 Donald R. Frey & Company
 EPS
 Ibsocom Systems
 Herco Microsystems
 Groundstar Software
 Harvard Software
 Hourglass Systems
 Human Systems Dynamics

Information Unlimited Software (IUS)
 Instant Software
 Ileboat Associates
 Lotus Development
 Management & Computer Services
 MCC Software
 MicroPro International
 Microsoft
 Nestar Systems
 North America MICA
 Northwest Analytical
 Olympus Software
 Osborne/McGraw Hill
 Peachtree Software
 Perfect Software
 Phase One Systems
 Pyramid Data Ltd
 Saturn Systems
 Shaffer & Shaffer Applied Research & Development
 Smoke Signal Broadcasting
 Solstar
 Softcorp International
 Softteam
 Software Arts
 Software Products International
 Software Resources
 The Software Toolworks
 Sorcim
 Special Delivery Software
 Structured Systems Group (SSG)
 Supersoft
 Systems Plus
 Tandy (Radio Shack)
 TeleVideo Systems
 Timberline Software
 Trac Line Software
 Vector Graphic
 Via Computer
 Viatr Corp
 Westlico
 Westminster Software
 Wicat Systems

Professional Services

Accountants-Microsystems
 AIAA Computer Services
 AERONICA
 AF Software Services
 AgData
 Agricultural Management Systems
 AR Rosenhan, Consulting Engineer
 Audent

APPLICATIONS SOFTWARE (Cont.)

Another Direction
 Appel & Krebs Software
 Applied Systems
 Arbutus Totalsoft
 Allvi
 Bristol Information Systems
 Cadco Systems
 Client Accounting Systems
 CMA, Micro Computer
 CMV Software Specialists
 Compaq
 Computer Consulting Services
 Computer Task Group
 Computer Systems
 Cyberta
 CYMA
 Dakline
The Denver Software Company
 Designers & Builders of
 Information Systems (DBIS)
 Digital Marketing
 Eagle Software Publishing
 EF Haskell & Associates
 Enterprise Computer System
 Farmland Computer Systems
 Faith Systems & Software
 HaHi Scientific
 Hewlett-Packard
 Howard Software Services
 Incom Systems
 Innovative Software Associates
 International Data Processing
 International Micro Systems (IMS)
 Jersey Micro Systems
 MCC Software
 McClintock
 Micro Business Systems
 Micro Data Business Forms II
 Systems
 Occupational Computing Company
 (OCC)
 Ohio Data Base
 PK Systems
 Professional Computer Services
 Professional Software
 Programmed Systems
 R&B Computer Systems
 SBC & ELCO Systems
 Sendero
 Single Source Solution
 Software Howe

Software Products International
 Software Resources
 Special Delivery Software
 SPCTRA/SOFT
 Star Value Software
 Stansoft
 System Integration Associates
 Systems Plus
 The Systems Shoppe
 Tandy (Radio Shack)
 TCS Software
 Technical Data
 The LWTW Group
 Thoman Software (TSC)
 TMS/MSC
 Trac Line Software
 Unique Information Systems
 VixCorp
 WPL Associates

Engineering/Scientific
 Advanced Structural Technology
 Anadrol
 Bindley Software
 Econ Associaiton
 Ecosoft
 Entek Scientific
 Golden State Business Systems
 Graphic Software Systems
 Hewlett-Packard
 Kalle Software Systems
 Land Innovation
 Liteboat Associates
 M. Hudis & Associates
 MPS Company
 On-Line Instrument Systems
 Pacsoft
 Parametrics
 R&L Software
 Remex
 Sinclair Optics
 Tandy (Radio Shack)
 Tensegrity
 Threshold Software
 Unique Information Systems

Graphics
 Accent Software
 ACCUMPILE
 AlphaBit Communications
 American Computers & Engineers
 Apple Computer
 AutoDesk
 Autographix

APPLICATIONS SOFTWARE (Cont.)

Breeze/QSD
 Business & Professional Software
 Cash Video
 Computer Stations
 Covington Computer Sales
 Cromemco
 Datagraph
 Datasoft
 Decision Resources
 Digital Research
 Epic Computer Products
 Escape Computer Software
 Ferox Microsystems
 Fox & Geller
 Geographix
 Graphic Communications
 Graphics Software
 Grid Systems
 GTCO
 Human Engineered Software
 Human Systems Dynamics
 Innovative Software
 Interactive Picture Systems
 Lotus Development
 Midwest Software
 Micro Control Systems
 Micro-Ware Distributors
 Micromotion
 MicroPro International
 Microsys
 Morgan-Fairfield Graphics
 Multisoft
 Omron Software
 Peachtree Software
 Precision Visuals
 Rainbow Computing
 Redding Group
 Reston Publishing
 Selanar
 Selqa Systems
 Software Publishing
 Software Resources
 Sond Computer of America
 Stowware
 Structural Programming
 Tandy (Radio Shack)
 Vector Graphic
 VisiCorp

Word Processing/Text Editing
 AlphaBit Communications
 Applied Microcomputer Systems

Applied Technology Ventures
 ARTSCI
 Atari
 Atom International
 Beaman Porter
 Broderbund Software
 California Digital Engineering
 Compac Systems
 Complete Computer Systems
 Computer
 Computer Development
 Computer Marketing Services
 Construction Data Control
 Cornucopia Software
 Cromemco
 Datamed Research
 Datemost
 Datatek
 Designer Software
 Designers & Builders of
 Information Systems (DBIS)
 Digital Marketing
 Emissis
 Hayden Book
 HFK Software
 Horizon Software Systems
 Human Engineered Software
 IJC
 Information Unlimited Software
 (IUS)
 International Micro Systems (IMS)
 Kensington Microware
 Letsoft
 Lifecart Associates
 Lifetree Software
 Logical Systems
 MAIC Software International
 Mark of the Unicorn
 MCC Software
 Metasoft
 Micro Metric
 Micromotion Ltd.
 MicroPro International
 Microsoft
 MPP (Microcobol Products)
 Muse Software
 Kozak Data Systems
 Oasis Systems
 Ohio Data Base
 Onset
 Owl Software
 Peachtree Software
 Perfect Software
 Professional Software

APPLICATIONS SOFTWARE (Cont) SYSTEMS SOFTWARE

Quark Engineering
 RealWorld Software
 Satellite Software International
 Scenic Computer Systems
 Select Information Services
 Sierra On-Line
 Silicon Valley
 Simulated Computer Products
 SOFSPY
 SoftText
 Software Dynamics
 Software Libraries
 Software Publishing
 Software Systems
 The Software Toolworks
 Star Computer Group
 Structured Systems Group (SSG)
 Supersoft
 Tandy (Radio Shack)
 TronWare
 Vector Graphic
 Victor Business Products
 JV Vilkaitis Consultants
 VisiCorp
 Western Software Development
 Wicat Systems
 Zenith Data Systems

Manufacturing
 Anacomp
 Bernard Cifler Associates
 Computimax
 Computer Methods
 Digital Micromirrors
 Felt Systems & Software
 High Technology Software Products
 Key Systems
 McCullough & Associates
 Micro Business Systems
 Micro Manufacturing Systems
 Midwest Computer Center
 Olympic Systems
 Professional Business Computer Systems
 SBCC & ELCO Systems
 Solzberg Research Associates
 TCS Software
 Tiptis
 Trac Line Software
 Vehmann

Operating Systems
 Apple Computer
 Aten International
 Cosmopolitan Electronics
 Digital Research
 FORTH
 Hunter & Ready
 IBM
 Intel
 Lifecraft Associates
 Logical Systems
 Microsoft
 MPSI (Microcomol Products)
 Phase One Systems
 Point 4 Data
 SMC Software Systems
 SofTech Microsystems
 System Integration Associates
 Tandy (Radio Shack)
 Western Electric
 Whitemiths Ltd
 Wicat Systems

Data Base Management
 AB Computers
 ABW
 Active Computer Enterprises
 Applied Software Technology
 Ashtech-Tate
 Caxton Software Publishing
 Computimax
 Computer Headware
 Condor Computer
 Construction Data Control
 Designers & Builders of Information Systems (DBIS)
 ESP Computer Resources
 Friend Software
 CMS Systems
 Groundstar Software
 Holliday Software
 Information Builders
 Information Unlimited Software (IUS)
 Innovative Software
 Insoft
 Jini Micro-Systems
 Key Software
 LJK Enterprises
 Micro Applications Group
 Micro Data Base Systems
 Microfro International

SYSTEMS SOFTWARE (Cont.)

Molecular Computer
 Multisoft
 Pascal Systems
 Perfect Software
 Shalati Systems
 The Small Computer
 Software Products International/
 Software Publishing
 Stoneware
 Structured Systems Group (SSG)
 Supersoft
 Systems Plus
 Tandy (Radio Shack)
 Tarbell Electronics
 TCS Software
 Texas Electronic Instruments
 Trac Line Software
 Uveon Computer Systems
 Vector Graphic

Data Communications

Abstract Systems
 Adac Computer Products
 Advanced Data Systems
 Arrow Micro Software
 Ation International
 The Communi Tree Group
 Computer Applications
 Computer Stations
 Contact Management Systems
 CP/M Users Group
 Cyberia
 Cypher Communications
 Technology
 Datemark Business Systems
 Digital Marketing
 Dow Jones
 Dynamic Microprocessor
 Associates
 Ferox Microsystems
 First Software
 Hawkeye Graphic
 Hayes Microcomputer Products
 The Headlands Press
 IBM
 IT Systems
 Unisys Systems
 Unisys Systems
 Logica
 Lovell
 Dawn McCrea Software
 Micro Systems Software

Microcom
 Microsoft
 Monroe Systems
 Mycroft Labs
 Nistar Systems
 NF Systems
 Philadelphia Consulting Group
 Phoenix
 Rabbit Software
 Small Business Systems Group
 Softronics
 Software Connections
 Software Module Marketing
 Software Society
 Southeastern Software
 Southwestern Data Systems
 SSM Microcomputer
 Supersoft
 Telephone Software Connection
 Vector Graphic
 Viacorp
 VME Personal Computing
 Westco
 Zenith Data Systems

Utilities

Adcom Software Products
 Anthro-Digital
 Bincore/QSD
 Computer Control Systems
 Competing
 Datamed Research
 Digital Constructs
 Digital Marketing
 Digital Research
 Dynamic Microprocessor
 Associates
 EZ Software
 Frontier Software
 Holliday Software
 Johnson Associates
 Unibit Associates
 Logical Systems
 MAP Systems
 Micro Applications Group
 MicroPro International
 Microtech Exports
 Minosys
 Panasonic
 Relational Systems International
 Small Records Associates
 Software Development
 Structured Systems Group (SSG)
 Supersoft
 Synapse Software

SYSTEMS SOFTWARE (Cont.)

Tandy (Radio Shack)
 Texas Instruments
 VisiCorp

Program Development/Debugging

Aspen Software
 Bysik
 Computer Data
 Computer Methods of Pennsylvania
 Computer Products
 Creative Solutions
 DakinS
 Data Access
 Dedicated Systems
 Delphi; Software Systems
 Design Software
 Digital Marketing
 Fox & Geller
 The Information People
 ISE
 Lifeboat Associates
 Marketing Essentials
 McMillan Computing Services
 Micro Focus
 Minosys
 Quelio
 Relational Systems International
 The Software Group
 Supersoft

Languages

Adventure International
 Alcor Systems
 American Planning
 Apple Computer
 Computer Innovations
 Digital Research
 Einstein
 Ellis Computing
 Excalibur Technologies
 Insoft
 ISE
 JRT Systems
 Lifeboat Associates
 MANIX Software Systems
 Microsoft
 Miller Microcomputer Services
 MPSI (Microsobel Products)
 Omnicol
 Omyx Systems
 Ryan-McFarland
 SWC Software Systems

Softech Microsystems
 STSC
 Supersoft
 Textron
 Whitemithre Ltd.

HARDWARE

Microcomputers
 Able Computer
 Accelerated Data Systems
 Acom Computers Ltd
 Action Computer Enterprise
 Alpha Micro
 Altos Computer Systems
 American Computers & Engineers
 Apple Computer
 Applied Digital Data Systems
 Applied Systems
 Atari
 Barrington International
 Basis
 Billings Computer
 Blackhawk Computers
 BMC Computer
 Burroughs
 Cadco Systems
 Callan Data Systems
 Campbell Scientific
 Canon USA
 Capro
 Casio
 Central Data
 Centurion Computer
 Charles River Data Systems
 Chrislin Industries
 Chrematics
 Cifer Systems Ltd
 Colonial Data Services
 Columbia Data Products
 Comark
 Commodore Business Machines
 Compaq Computer Systems
 COMPAQ Computer
 CompuPro
 Computer Ancillaries Ltd
 Computer Automation
 Computer Devices
 The ComputerNet
 Computablink
 Control Data
 Control Logic
 Convus Systems

HARDWARE (Cont.)

Cromemco
 Cybersystems
 Data General
 Data Terminal Systems
 Datamac Computer Systems
 Datamedia
 Datapoint
 Datavue
 Datavon
 Delta Data Systems
 Digicomp Research
 Digilog Business Systems
 Digital Design & Development
 Digital Equipment
 Digital Laboratories
 Digital Microsystems
 Display Data
 Distributed Computer Systems
 Dual Systems
 Durango Systems
 Dynabyte
 Dynalogic Info-Tech
 Dynateam
 E&I Instruments
 E&U Engel Consulting
 Eagle Computer
 ECS Microsystems
 Epic Computer Products
 Epson America
 Eddy
 Femaril Computer Systems Ltd
 Forethought Products
 Fortune Systems
 Franklin Computer
 Fujitsu
 Future Computers Ltd
 General Digital Industries
 Gifford Computer Systems
 Glimix
 GMR
 Grid Systems
 Grundy Business Systems Ltd
 Hewlett-Packard
 Honeywell Information Systems
 IBM
 ICL Computers
 IWS International
 Infotels
 Instrumentation Laboratory
 Integrated Business Computers
 Intel
 Intelligent Systems

Interactive Systems Technology
 Interex Data Systems
 InterTechnique
 The IPAC Group
 Ithaca InterSystems
 Kaycomp Computers
 Keuffel & Esser
 LNW Computers
 M/A-COM Office Systems
 Mac Computer
 Mac/Basic Four
 Martec International Electronics
 Matrixx Electronic Systems
 MCIM Computers
 Mercator Business Systems
 Micro Five
 Micro Source
 Micro Technology Unlimited
 MicroAPL Ltd
 Microbar Systems
 Molecular Computer
 Monroe Systems
 Monrow Designs
 Motorola
 Multi-Tech Systems
 Multitech Electronics
 National Semiconductor
 NCR
 NEC Information Systems
 Nectar Systems
 NINC Electronics
 North Star Computers
 Northern Telecom
 Numentronix
 Olivetti
 Olympia USA
 Omnilbyte
 Omicel
 Onyx Systems
 Osborne Computer
 OSM Computer
 Ostrona
 Panasonic
 Pegasus Data Systems
 Perkin-Elmer
 Personal Micro Computers
 Portek Computer
 PHC
 Philips Data Systems
 Plenary Systems
 Point 4 Data
 Polaris Microcomputers
 Product Associates
 Quantum Computer Systems Ltd
 Quasar Data Products

HARDWARE (Cont.)

Quay
 Rain
 Rain Ltd
 Regency Systems
 RSI of America
 Sage Computer Technology
 Samyo Business Systems
 Scenic Computer Systems
 SCI Systems
 SCI-COM Computer Systems
 Scientific Data Systems
 Scientific Micro Systems
 SDsystems
 Seattle Computer Products
 Seesqa Computer
 Sharp Electronics
 Sierra National
 Sinclair Research
 Smoke Signal Broadcasting
 Sony
 Sord Computer of America
 STM Electronics
 Syntex Datronics
 Tab Products
 TanData
 Tandy (Radio Shack)
 Tarbell Electronics
 Tektronix
 Teleram Communications
 TeleVideo Systems
 Terak
 Texas Instruments
 Three Rivers Computer
 Torch Computers Ltd
 Toshiba America
 Trivector Commerce Ltd
 TRW-Fujitsu
 Vector Graphic
 Victor Business Products
 Victory Computer Systems
 Wang Laboratories
 Wave Mate
 Western Digital
 Wheat Systems
 Windtek
 Xerox
 Xycorn
 Xylogics
 Zeda Computer International
 Zenith Data Systems
 Zonotec
 Zilog

Witchware

Amper
 Apple Computer
 Atari
 Automated Resource Management
 BASP Systems
 Comark
 Computer System Associates
 Compaq Systems
 Cynthia Peripheral
 DMA Systems
 Eagle Computer
 Epic Computer Products
 Itronik
 Hewlett-Packard
 International Memories
 Iwatsu Olivetti
 Memorex
 Micro Peripherals
 Microcomputer Systems
 Microtech Business Systems
 Miniscribe
 NEC Information Systems
 New World Computer
 Plessey Microsystems
 Quantum
 Rodime
 Rotating Memory Systems
 Seagate Technology
 Sharp
 SyQuest Technology
 Taliqwest Technologies
 Tandon
 Texas Instruments
 3M
 Western Dyne
 Xocomp
 Zenith Data Systems

Diskettes

Alpha Micro
 Anderson Jacobson
 Apple Computer
 BGI Technology
 Chrislin Industries
 Comark
 Commodore Business Machines
 Franklin Computer
 Hewlett-Packard
 Itronik
 Micro Peripherals
 Micro Technology
 Micro-Scl
 Micropolis
 Personal Micro Computers

HARDWARE (Cont.)

Remex
 Scientific Micro Systems
 Shugart
 Tandon
 TEAC
 United Peripherals
 Vista Computer
 Zenith Data Systems

Add-on Memories
 Advanced Micro Devices
 Alpha Micro
 Alpha Omega Computer Systems
 Andromeda Systems
 Apparal
 AST Research
 Cambex
 Central Data
 Christlin Industries
 Chromatics
 Commodore Business Machines
 Computer Extension Systems
 Cromemco
 Datamed Computer Systems
 Davong Systems
 Digicomp Research
 Dual Systems
 Eventide
 Forethought Products
 G. E. Intertel Systems
 General Robotics
 Heurikon
 IDG Associates
 Infotek
 Ithaca InterSystems
 Matrim Electronic Systems
 Microsoft
 Minotek
 Monolithic Systems
 Monrow Designs
 MPC Peripherals
 Omega MicroWare
 PEIKA
 Pleassey Microsystems
 Pleassey Peripheral Systems
 Computer Products Div
 Quantum
 Quatronics
 Saturn Systems
 Seattle Computer Products
 SemDisk Systems
 Smoke Signal Broadcasting

SSM Microcomputer
 Stellion Two
 Systems Group
 Tecmar
 Telesak
 Trendata/Standard Memories
 Xodos

Printers

Anadix
 Andersen Jacobson
 Apple Computer
 Azurdata
 Campbell Scientific
 Centronics Data Computer
 Commodore Business Machines
 Computer Devices
 Computer Transceiver Systems
 Computers International
 Comrex International
 Data Terminals & Communications
 Datapoint
 Dataproducts
 Datasouth
 DP-Tek
 Eaton Printer Products
 Epson America
 Fujitsu
 General Electric
 Heath
 Heaton
 Hewlett-Packard
 HI-C Printer Products
 Invoscribe
 Integral Data Systems
 Intergen
 Kaye Instruments
 Marmonmann Tally
 Memadyne
 Microprocessor Systems
 Okidata
 Olivetti
 Olympia USA
 Panasonic
 Practical Automation
 Printer Products
 Qantas
 Racal-Dana
 Samyo Business Systems
 Sentinel Computer
 Smith-Corona
 Star Micronics
 Tandy (Radio Shack)
 Texprint
 Trendcom/JM

HARDWARE (Cont.)

Tymshare	Candall Data
Vector Graphic	General Datacomm Industries
Zenith Data Systems	GTE Lenkurt
 	Hayes Microcomputer Products
Display Monitors	Hayden-Packard
Comma International	ICOT
Dotworks	Interton Systems
Zenith Data Systems	Microperipheral
 	Multi-Tech Systems
Modems	NEC Information Systems
American Bell	Novation
Astrotek	Nu Data
Atari	Omnitec Data
Bizcomp	Prentice
Campbell Scientific	Recal-Vadic
Comnetek	Rison
Codex	Tek-Com
Coherent Communications	Timeplex
ComData	TNW
Commodore Business Machines	Tri-Data
Datapoint	Tuck Electronics
Datatronix	U.S. Robotics
Daten	Universal Data Systems
	Ven-Tel
	Visionary Electronics

Microcomputer Reports



GLOSSARY OF ABBREVIATIONS AND TERMS

- AC** alternating current
- ACC** asynchronous communications controller
- access time** 1. the interval between the initial request for information from the system and its final output. 2. the interval between the initial request to store information and actual storage
- addl** additional
- address** the location where information is stored—usually assigned a label, name, or number
- ALGOL** algorithmic language
- ALU** arithmetic logic unit
- ANL** alphanumeric
- ANS** American National Standard
- ANSI** American National Standards Institute
- APL** a programming language
- arith** arithmetic
- ASCII** American Standard Code for Information Interchange
- ASR** automatic send/receive
- Assembler** computer program that produces machine instructions from symbolic input data
- async** asynchronous; a mode of communications that provides a variable time interval between characters during a transmission
- aux** auxiliary
- avail.** available
- avg** average
- B** byte; a segment of adjacent binary digits, usually shorter than a word
- b** bit—binary digit; the smallest unit of information used in a computer
- BASIC** Beginners' All-Purpose Symbolic Instruction Code
- BCD** binary-coded decimal
- bisync** bisynchronous; data transmission in which the synchronization of characters is controlled by timing signals at the sending and receiving stations
- bit map** a type of display screen that features an image generated by the bit map memory; the bit map has a bit for every point on the screen and usually produces a very high resolution

BMMC basic monthly maintenance charge
bootstrap a machine routine in which the initial instructions are sufficient to bring the remainder of the routine into the computer from an input device
bpi bits per inch
bps bits per second
BSC binary synchronous (bisynchronous) communications
bubble memory a nonvolatile memory system that uses bubblelike magnetic fields to store and retrieve data. This type of memory is faster than magnetic tape or hard disk devices and can be used in harsh environments
buffer an area of storage temporarily reserved for use in performing input/output operations into which data can be read, or from which data is written
bus a data channel (usually between a computer and peripheral equipment) over which electrical signals and data are transmitted

CAD computer-aided design
CAE computer-aided engineering
CAI computer-aided instruction
CAM computer-aided manufacturing
CCITT Consultative Committee for International Telephony & Telegraphy
chan channel
char. character; a letter, digit, or other symbol that can be represented in computer language by a unique binary code
CMOS complementary metal oxide semiconductor
COBOL Common Business-Oriented Language
CODASYL Conference on Data System Languages
col column
config configuration
control controller; directs the transmission of data over the data links of a network or peripheral device
cpi characters per inch
cpl characters per line
CP/M Control Program for Microcomputers (Digital Research)
cps characters per second
CPU central processing unit
CRT cathode-ray tube
cursor an indicator used in CRT terminals that points out the character to be corrected or the position where data is to be entered
cycle time the time needed to write or read into a computer system's memory
cyl cylinder

DASD direct access storage device
dbl double
DBMS data base management system

DC direct current
DDP distributed data processing
debug to check the logic of a program to isolate and remove mistakes from a computer program
diag diagonal
direct addressing a method of accessing a register so that the contents are immediately acted upon
DMA direct memory access; permits input/output transfers directly into or out of memory without going through the processor's general registers
doc document
DOS disk operating system
DP data processing
dpm documents per minute
DRAM dynamic random-access memory

ea each
EBCDIC extended binary-coded decimal interchange code
ECG error checking and correcting
EDP electronic data processing
EIA Electronics Industry Association
EPROM erasable programmable read-only memory
equip. equipment
excl excluding

FDX full duplex
file management the recording, duplication, distribution, storage, retrieval, display, and hard copying of documents
font a character set using a particular style and size of type
FORTRAN formula translator

G 1. **giga** (billion) 2. 1,073,741,800 units
GB gigabyte (billion bytes)
GP general-purpose

HASP Houston Automatic Spooling Processor
hd head
HDLC high-level data link control
HDX half duplex
horiz horizontal
HP-IB Hewlett-Packard Interface Bus
hr hour
Hz hertz

IC integrated circuit
in. inch

Intel include

interface the connection or point of connection of separate devices or systems

interpreter a program that translates and executes a source language statement before it performs the same operations on the next one

interrupt a break in the normal flow of a computer routine that allows the computer to sense special conditions without scanning the entire system

I/O input/output

IOP input/output processor

ips inches per second

ISAM indexed sequential access method

JCL job control language

K 1. kilo (thousand) 2. 1,024 units

KB kilobyte (thousand bytes)

kHz kilohertz (thousand hertz)

KSR keyboard send/receive set

kybd keyboard

LAN local area network; links computer systems, terminals, storage devices, and programs over relatively small geographic areas for rapid communication

LCD liquid-crystal display

LED light-emitting diode

lpi lines per inch

lpm lines per minute

LSI large-scale integration

M 1. mega (million) 2. 1,048,576 units

mA milliamperes

mag magnetic

max maximum

MB megabyte (million bytes)

MHz megahertz (million hertz)

min minimum

MIS management information system

mo month

modem a device used to modulate and demodulate signals transmitted over various communications facilities

MOS metal oxide semiconductor

mouse a device used to control the position of the cursor on a display screen; as this handheld device is moved along the top of a desk, it moves the position of the cursor on the display

MRJE multiple remote job entry
μsec millisecond (thousandth of a second)
MSI medium-scale integration
MTBF mean time between failures
mux multiplexor

NA not applicable
NMOS negative channel metal oxide semiconductor
nonvolatile memory a type of memory that continues to hold data even when power has been disconnected
NRZ nonreturn to zero
NRZI nonreturn to zero inverted
ns nanosecond (billionth of a second)

OEM original equipment manufacturer
oper operation, operator
opt. optional
OS operating system

PC printed circuit
PE phase encoded
pixel picture element
PMOS positive channel metal oxide semiconductor
programmable
proc processor
PROM programmable read-only memory
protocol a code involving characters and symbols without syntax; it is not a language, but it is used for communications by a computer system
pt point

QSAM queued sequential access method
QWERTY the standard typewriter keyboard arrangement

RAM random-access memory
rd read
REPROM reprogrammable read-only memory
req require
RJE remote job entry
RO receive only
ROM read-only memory
RPG report program generator language
rpm revolutions per minute

SAM sequential access method
SDLC synchronous data link control

a/b second
serial interface transmission of data bit by bit rather than in bytes
SMD storage module drive
SNA systems network architecture
SOS silicon on sapphire
spec specification
SSI small-scale integration
stack an area in memory where data is stored temporarily
std standard
sync synchronous; a mode of communications in which transmission is timed by a signal generated by a clock
SYSGEN systems generation

term, terminal
trk track
TTL transistor-to-transistor logic
TTY teletypewriter
TWX teletypewriter exchange service

UDLC Univac Data Link Control
unavail unavailable

v volts
VDT video display terminal
VDU video display unit
vert vertical
VLSI very large scale integration
VMOS n-channel metal oxide semiconductor
volatile memory a type of memory that permanently loses all stored information when the power has been removed
VS virtual storage

w/ with
WATS wide area telecommunications service
WCS writable control storage
wd word
w/o without
worksta workstation
WP word processing

Xfer transfer

yr year

Special Characters

- ▷ programmed microprogrammed
- ▷ sec microsecond (millionth of a second)
- information unavailable at press time
- % percent
- / per

CONSIDERATIONS FOR DEVELOPING MICROCOMPUTER NETWORKS FOR MANUFACTURING APPLICATIONS

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EVALUATING MICROCOMPUTERS AND COMPUTER NETWORKS

Microcomputers offer low-cost and efficient computing resources for manufacturing control systems. In some companies, they can replace mainframes and perform functions for which automation could not otherwise be justified. In large companies, microcomputers can be used along with minicomputers and mainframes, providing functional flexibility and accessibility as well as relieving the larger machines of substantial work. Even in very large companies, microcomputers can be applied as standalone processes and as elements in computer networks of all sizes.

This article is intended to support manufacturing managers in evaluating microcomputers and networked computer systems in relation to their companies' information needs. It discusses microcomputer applications in manufacturing and surveys the advantages and disadvantages of microcomputers as standalone and as networked systems. Recognizing the trend toward networked systems, this article discusses network communications; it is supported with an appendix that focuses on the technical issues and terminology that managers should be aware of when planning a networked system.

Advantages of Microcomputers

In relation to mainframes—and even minicomputers—microcomputers offer significant advantages in terms of response time, dedicated use, software availability, reliability, and cost.

Response Time. Microcomputer response time can be faster than that of minicomputers or mainframes because the microcomputer is dedicated to a single user's data processing tasks. In larger systems,

work may be processed by a communications controller, passed to the main computer through a telephone line, wait queued for processing, and then be passed back to the user through the network. Although the microcomputer's actual computing time is significantly longer than that of the larger machines, given selected applications, little computing usually is required to serve most requests. When requests do not involve complex retrievals and calculations (the forte of mainframe computing), microcomputer response times can be shorter than those of a mainframe.

Dedicated Use. To the extent that microcomputers are under the user's control, they can free the user from the delays sometimes associated with receiving computing services from a central DP organization. When trained in basic microcomputing operation, users can often solve business problems with standard hardware and software packages in less time and at lower cost than can be achieved by a central DP group. In some cases, dedicated microcomputers can enhance security by limiting data security responsibility to one person and by giving that person sole access to the program and data diskettes.

Software. Microcomputers enjoy the advantage of recently designed software—that is, software that tends to be easier to use and more flexible than minicomputer and mainframe software. These advantages are due in part to concurrent developments in hardware and software technology, the relative simplicity of programming for microcomputers, and the highly competitive market in which software is usually sold directly to the users.

Reliability. Microcomputer reliability is generally much better than that of minicomputers and mainframes, which are significantly more complex and, if older, use less advanced and less reliable technology. Although service is better for the larger machines, the actual result often favors the microcomputer.

Cost. Microcomputers enjoy a cost advantage. A fully equipped and staffed mainframe costs millions of dollars—substantially more than a fully equipped and staffed microcomputer. (A microcomputer with good memory and storage capacity and an assortment of business software can be purchased for less than \$12,000.)

Disadvantages of Microcomputers

Although microcomputers are inexpensive and relatively reliable, they have disadvantages that must be considered. Slow response time for certain kinds of applications and lack of vendor support are the major drawbacks.

Size and Speed. From a user's perspective, the computer's speed is related to the time required for data to move through the network to and from the computer, the time data spends queued for the pro-

cessor, actual computing time, and the time spent waiting for data to be transferred to and from storage units. Microcomputers have no network and waiting time but compute at rates from 10 to 1,000 times slower than those of mainframes. Therefore, applications involving many mathematical calculations are probably better performed by larger computers.

Microcomputer data transfer rates are slow and the disk drives have limited storage capacity. One large Winchester disk drive sold for microcomputer applications holds approximately 40 million characters, compared to the more than 300 million of one vendor's mainframe. The mainframe is capable of addressing dozens of disk drives, whereas the microcomputer is generally limited to three or four.

In many manufacturing systems applications, the data is too great to pass through a single keyboard. Because microcomputers support only one user at a time, they may be adequate for manufacturing systems in only very small companies. Although some commercially available microcomputer operating systems allow more than one simultaneous user and more than one keyboard, they may not solve the speed problem, because overall system capacity is still limited by processor speed and software efficiency. If large volumes of data must be accessed in a short time, microcomputers are unsuitable. Similarly, complex applications such as regenerative material requirements planning (mrp) and product costing are faster on mainframes.

Vendor Support. An important microcomputer advantage is also a major disadvantage: independence from other users and the central DP facility also means that support responsibility falls on the user. Microcomputer hardware and software vendors depend on volume for profit. Some microcomputer hardware is supported through a carry-in repair service, any hardware problem is likely to put a microcomputer out of service for at least a day and possibly for weeks. Sometimes hardware support involves mail-in service, requiring between two and ten weeks. Service contracts for in-plant service are available, but, if parts are unavailable, in-plant service may be no faster than carry-in service. Service quality varies because many service technicians work on many vendors' products. Offsetting the support disadvantage is the fact that microcomputers are simpler than larger ones and tend to need less service.

Software support usually is offered in the form of a hot-line phone number. If the hot line is restricted to dealers, the user must persuade the dealer that the software publisher should be contacted. Some vendors offer no software support.

MANUFACTURING APPLICATIONS OF MICROCOMPUTERS

As previously discussed, microcomputers are inappropriate for applications that require complex mathematical calculations or high volumes of data. Because they can provide relatively low-cost and

fast computing, they are appropriate for the following manufacturing applications:

- **Financial systems**—For microcomputers, software packages include accounts receivable and payable, general ledger, and payroll. (These microcomputer applications are especially beneficial in small companies automating financial functions for the first time.)
- **Word processing**—Many companies have found that microcomputers can contribute significantly to office efficiency by eliminating much manual effort.
- **Spreadsheet programs**—Financial modeling programs (such as VisiCalc and SuperCalc) developed for microcomputers are powerful tools for projecting financial statements, planning cash flow and production requirements, and performing analyses involving data in time-series form. In addition, available software can convert spreadsheet data into graphic form.
- **Inventory control**—In small companies and organizations within large companies, the benefits of automating inventory control generally justify the purchase price of the hardware and software. Microcomputer-based inventory control is especially successful when one person is accountable for inventory control. Most available software assumes that all transactions are reported through a single keyboard, and users should not have to vie for access to it.
- **mrp**—Some companies are running mrp systems on microcomputers, and industry observers expect software costs to drop soon below \$10,000, bringing mrp within the reach of even small companies.
- **Order entry**—Some financial systems include order entry, shipping, and billing functions; the computer generates order and shipping documents, invoices, and a variety of reports and graphs based on sales history. It automatically calculates prices and discounts and sales functions. Some systems are also interfaced to accounting systems.
- **Direct data entry**—Inventory control systems that use data input devices other than the microcomputer keyboard are available. For example, interface hardware for bar-code readers is on the market, although on a limited basis. Improved disk data storage technology is expected to reduce access times and increase file storage capacities.
- **Bills of material**—Bill of material systems available for microcomputers are being enhanced to provide more features and functions. Improved systems are likely to be much faster and to support at least one form of engineering change control.
- **Purchasing and receiving functions**—Microcomputers are well suited to purchasing and receiving applications because response time and reliability are more important than computing capacity. Purchase order preparation requires the close control of the buyer; a dedicated computer can access the limited data concerning vendors and ordered items. The receiving function in-

volves an interface with purchasing and little computing. The receiving system simply captures new order information from purchasing, stores it until the material is received, and transmits it to the stockroom and to accounts payable or diverts it to quality control or to the buyer.

- **Shop floor control**—Software for microcomputers includes shop order creation and work-in-process tracking by order and by work center.
- **Quality control analysis and labor productivity measurement** can use currently available statistical analysis systems. If the microcomputer-based receiving and shop floor systems can collect information about scrap and rejects, the basic data required for quality control analysis is available. If the shop floor control system can collect clock card and job ticket information, and if the bill of material system contains standard times, labor productivity measurement can be performed by a report-writing program.

Benefits of Networked Systems for Manufacturing Applications

Microcomputers can be implemented as standalone systems or networked in such a way that each user has the benefits of a dedicated computer and can share information with other network users. A computer network consists essentially of three or more computers that can communicate with each other. The network configuration can include mainframes and minicomputers as well as microcomputers. In addition, it can include a wide variety of special-purpose devices (e.g., printers, disk drives, machine sensors) appropriate for the specific applications. The network can link users in a limited geographical area (i.e., a local area network) or in different cities (i.e., a public network).

Microcomputer system networks for manufacturing applications can provide many benefits. Few of these, however, can easily be quantified. Among the intangible but significant benefits of microcomputer networks are the following:

- They coordinate the operation of remote plants, warehouses, and offices. For instance, materials can be transferred between plants in several cities according to a common manufacturing plan. Communications over the network help to ensure that a fabrication plant makes the parts needed by the assembly plant to meet its schedules. The network can also link distribution warehouses and the purchasing department to the assembly plant.
- They communicate and coordinate plan changes quickly. An assembly schedule change that alters component parts requirements must be reflected immediately in the fabrication plant's schedule to prevent production of unnecessary stock and minimize the likelihood of shortages.
- They foster formal system success by promoting a sense of responsibility among users. Many manufacturing systems fail be-

cause users neglect to maintain accurate data. If one person is responsible for maintaining the on-hand balance information for a group of parts and has the necessary computer-based tools at hand, the reliability of the data should dramatically improve. One reason is that the person becomes accountable for accuracy, and the modular microcomputer software can be very responsive to the user's information needs. Furthermore, the person who is given this control over the data will develop a sense of personal pride in the accuracy and timeliness of the data.

- They contribute to the productivity of manufacturing managers. Electronic mail and word processing features as well as easy access to internal and external data sources and spreadsheet analysis programs can be of significant value.

ALTERNATIVE MICROCOMPUTER SYSTEM CONFIGURATIONS

Most manufacturing system applications operating on microcomputers are single-machine systems in which one microcomputer performs all the required functions at different times. The user can run any function but only one at a time. Because system modules are reasonably well integrated and all files can be updated immediately, duplicate data entry for separate modules or programs is infrequently required.

The single-machine system is adequate for very small manufacturing companies because the daily volume of data can be handled with one keyboard, one CRT, and one printer in one working day. In larger companies, however, the single-machine manufacturing system is inadequate because there are not enough hours in the day for everyone to use it. One way around the keyboard bottleneck is to purchase several microcomputers and additional copies of the manufacturing system software. Most available software cannot coordinate the operation of several computers using copies of the same software. Each user has to maintain a separate copy of required data. The effort required for multiple entry of data into several microcomputers and for verifying that all copies are identical negates the advantages of duplicating the software.

Vendors of microcomputer manufacturing systems recognize the keyboard bottleneck and are designing a second generation of software primarily aimed at relieving it. Three methods are being considered: multiprogramming/multi-user systems, centrally controlled networks, and distributed networks. Each has its advantages and disadvantages; the trade-offs are discussed in the following sections.

Multiprogramming/Multi-user Systems

The least complex solution to the keyboard bottleneck problem is the addition of keyboards. Currently available operating system software mimics multiprogramming minicomputer and mainframe operating systems and permits a single microcomputer to operate several

programs simultaneously. Several "dumb" terminals can be connected to a microcomputer, and each can independently support a user with a keyboard. In comparison to multiple microcomputers, multiprogramming/multi-user operating systems represent an improvement in communications between users. Because all users are linked to one computer, they can share a single data base and the major communications problems associated with separate computers are resolved.

Although multiprogramming/multi-user operating systems can resolve the keyboard bottleneck to some extent, they raise questions about the ability of a single microcomputer to handle many users simultaneously without losing a significant portion of the response-time advantage. These systems limit growth potential to the capabilities of a single processor. Furthermore, only one user at a time has access to the system controls and disk drives.

Centrally Controlled Networks

Some commercial networked systems permit a number of microcomputers to share common data on a central disk drive. The disk drive controller can accept simultaneous input from several microcomputers and acts as a central network controller. All requests for data from the disk, all data to be stored on the disk, and all messages between microcomputers pass through the central controller, which does the "bookkeeping" required to make the network run smoothly.

A major benefit of a centrally controlled network is the division of tasks among several intelligent computers. The controller relieves the microcomputers of most of the work associated with networking, and they relieve the controller of work on application programs. Theoretically, networked systems can support a very large number of workstations. When a single network controller is loaded to capacity, additional ones can be added to support more workstations.

Distributed Control Networks

The third microcomputer system configuration eliminates the central data base, distributes data among the users according to maintenance responsibilities, and uses software that permits users to communicate directly through the network; each system module is responsible for a share of the control duties.

Eliminating the central network controller and the central data base has advantages. First, distributed networking permits users to control the data. In contrast, a central data base spreads this control among users and hinders data accuracy measurement on an individual basis. A second advantage is that distributed networking systems separate individual workstations and give the system designers freedom to match hardware capabilities to tasks to a greater degree than do centrally controlled systems—that is, distributed manufacturing systems can include all sizes of hardware, various installation locations, and several organizations.

For example, a company can operate a broad range of hardware, all using a single, integrated software system. The company's major applications (e.g., mrp and product costing) can be run on a high-speed mainframe computer. Buyers, schedulers, and planners can work independently and access the network through dedicated microcomputers. Users enjoy the combined advantages of a dedicated computer, the high-speed mainframe computing, and access to data entered and verified by others.

Distributed networking systems are more expensive to program than simpler network configurations because a much wider range of hardware must be accommodated. Support costs are also higher because knowledge of different hardware and software is required to maintain the system. Although distributed networking systems are infrequently used, they are expected to be more common by the end of this decade.

Centralized versus Decentralized Network Control

Network control is centralized when only one of the devices attached to the network is able to route messages. In a centralized network, all messages from all remote devices are transmitted to the one device that can perform routing. That device interprets the messages and reoutes them to their destinations. In a completely distributed network, every device would be capable of routing messages directly to every other device. Centralized networks are generally cheaper to create than distributed ones because only one device needs to be programmed for message routing and only one program needs to be changed when the network changes. Because every message has to be transmitted twice (once to the controller and once to the destination), however, the overall network capacity is reduced.

Most large networks are a hybrid of centralized and distributed control. Some devices are able to route messages directly, some are able to route part of their traffic directly, and some must rely entirely on central controllers.

NETWORK COMMUNICATIONS

When two people talk on the telephone, they are exchanging messages. One person talks for a time, then the other. Sometimes both begin talking at the same time and pause, and then one person takes control of the conversation and proceeds. Computer communication works in a similar fashion. However, it is usually shorter and contains little redundant information, maximizing the rate of information flow. Error-detection schemes built into the messages permit frequent error checking.

For instance, if one computer is to inform another that a new item has been added to the master file and that the receiving computer should update its files, the sending computer transmits several pieces of information. The transmission probably includes a code indicating that the message concerns a new record on the item master,

the new item's part number, its description, and other specific information. Because the transaction can involve more than 100 characters, it may be broken into several messages, each related to the other by additional codes and protected during the transmission by error-detection codes. The receiving computer receives the first message, learns that a new item master record is involved, and awaits the remaining parts of the transmission. At the end of each message (or in some systems, the entire transaction), the receiving computer sends an acknowledgment back to the sending computer. If errors are detected, the receiving computer returns a negative acknowledgment and the sending computer repeats the data until a positive acknowledgment is received.

Communications Protocols

The rules governing the interaction of network devices are called protocols, and specifications range from voltages to message formats.

The following list briefly describes types of communications protocols, and they are discussed in depth in the appendix of this article.

1. Physical protocols cover specifications for transmission media, including electrical wire, microwave, fiber optics, and audible sound.
2. Link protocols govern the logic used to transmit messages, including synchronous, asynchronous, and binary synchronous communications.
3. Network and transport protocols determine how messages are routed to devices in the network.
4. Session and presentation protocols are used to specify connection and disconnection procedures and to restrict transmission time.
5. Application protocols specify the formats with which the networked computers communicate application-specific information.

Although vendors are attempting to develop standardized protocols, none is likely to emerge as preeminent. Greater standardization should reduce the number of design decisions that must be made. A higher degree of standardization can also be expected to benefit users by offering a variety of successful solutions to communications problems as well as lower system costs.

Reducing Network Communications Costs

In the absence of standardized protocols, network communications costs can be reduced by good design. For example, designs that minimize telephone bills, the length of communications lines, and the number of lines can achieve significant savings.

Public Facilities. Local area networks are usually restricted to small geographic areas and can use private communications lines.

For large, geographically spread networks, however, the cost of private communications lines is usually prohibitive, and public lines are used. Lines leased and conditioned by the phone company can achieve transmission speeds fast enough to drive a 600-line-per-minute printer, which is adequate for most manufacturing purposes. The cost of long-distance computer communications is usually related to the services provided by the telephone company. To minimize telephone bills, potential users can consider arrangements with telephone companies that sell time on private telephone lines at reduced cost.

Line Connection Schemes. Another source of savings is the physical design of the network. For example, a network connecting Boston with New York, Philadelphia, Cleveland, and Chicago could use lines from each city to all other cities, a total length of about 5,000 miles. If, however, the same network connected only Chicago with Cleveland, Cleveland with New York, and New York with both Philadelphia and Boston, it might accomplish the same objectives with only 1,100 miles of lines. Although the computers in Cleveland and New York might have to be larger to handle the additional traffic, the total system cost could be substantially reduced. Thus, the physical design of large networks is a complex task requiring a good knowledge of the applicable tariffs, networking technology, and the traffic passing over the network.

Multiple Transmissions. Multiplexers, devices that allow more than one network conversation at a time on a single line, can extend the use of single telephone lines. A frequency multiplexor transmits several different electrical frequencies at one time, superimposing different computer conversations on different frequencies. Few computers make full use of the available time on the line; time-division and statistical multiplexors coordinate traffic, permit different conversations to occur at different times, and operate fast enough to make delays nearly unnoticeable by the user. Time-division multiplexors parcel out time in predetermined pieces, whereas statistical multiplexors parcel it out according to the need of each device. Statistical multiplexors make better use of the line than time-division multiplexors, but they cost more. Multiplexors can substantially increase the effective capacity of a communications line. Their cost is easily justified when the line is long and costly, used by many devices, and inadequate for heavy traffic.

FINAL CONSIDERATIONS

Managers of companies considering or planning a microcomputer network should recognize that the technology is still developing. They should proceed with caution and evaluate the following issues:

- Technical complexity—Although improved standards are reducing the complexity of network design, designing an effective and efficient network requires experience and expertise. In addition

- to the cost of design experts, companies can expect substantial continuing costs of personnel to support the network.
- **Technical development**—As discussed in this article, standard protocols have evolved through the physical and link levels of communication, and the work continues. Recent announcements of standard networking schemes by several major computer vendors promise significant benefits for new installations. If standards are different from those adopted for existing networks, costs for expansion, change, and additional maintenance may be incurred.
 - **Expanded capacity**—Like all computer systems, successful networks usually grow. As users discover the network's capabilities, they use it more. Managers must be certain to avoid having planned network designs fit the estimated traffic volumes so closely that they require major expenditures to add new devices when increased capacity is needed.

APPENDIX

Considerations for Planning Computer Network Communications

This appendix is intended to support the project manager responsible for computer network project planning. It offers a discussion of communications protocols, defines some of the basic terminology, and describes the current state of standardization.

Physical Protocols

Communications between computers can be transmitted through various media, including electrical wire, microwave, fiber optics, and audible sound transmission. Since the same principles apply to all media, for simplicity this discussion considers only transmission through a wire.

Digital and Analog Transmission. One of the first design decisions for a physical communications protocol is determining whether the transmissions must be digital or analog. If telephone lines are used, communications must be in an analog mode because the phone system is designed primarily for analog transmission. (Although Bell Telephone Company provides digital data service among some cities, most computer communication is analog.) For analog transmissions, a modem is required to convert the computer's digital signal to an analog one, and a second modem is required at the receiving end to convert it back.

Because Bell Telephone was among the first to produce and use modems, the Bell physical protocols have become relatively standard throughout the communications industry. Bell's standards specify physical characteristics such as voltage levels, the rate of bit transmission, and other basic properties. Most other modem manufacturers make units that are advertised as Bell compatible.

Digital transmission requires no modems and can be used in most plants. If all the devices in the network have the same voltage levels and speeds, they can be directly wired together; otherwise, equipment to compensate for the differences is needed. One good approach to coordinating mismatched devices uses a pair of modems to perform analog and digital conversions.

Several commonly accepted standards have been developed for digital input and output from the devices on a network. One, for instance, specifies that the bits making up a transmission should move in serial form (i.e., one after the other) down a single wire and defines voltage levels and other physical characteristics. In parallel transmission, bits making up a single character travel in parallel, each bit on its own wire. Although parallel transmission can be faster than serial, it is more sensitive to electrical interference and is useful over only very short distances.

Bandwidth Considerations. Multiple signals can be transmitted over a single circuit if each signal is transmitted on its own frequency. The term bandwidth refers to the range of frequencies used on a line, the number of simultaneous transmissions possible, and, therefore, the data capacity of the line. Broadband lines can handle much more data than baseband ones but also require relatively expensive conversion equipment for each device in the network.

Broadband signaling is most economical when the volume of data transmission is high, distances are great (involving high costs per circuit), and the devices on the network are permanently attached. Transmissions within a manufacturing plant are likely to use baseband signaling because distances are relatively short, wiring costs relatively low, transmission volumes light, and the number of devices high.

Link Protocols

Link protocols are the logical methods used to pass messages. The two types are synchronous (sync) communication, which uses an internal clock to synchronize transmissions in time, and asynchronous (async) communication, which allows all devices to transmit at will. Asynchronous communication is usually one character at a time (i.e., the message length is a single character), whereas synchronous communication consists of variable-length messages. Because error-detection and confirmation transmissions are included in both types of transmission, asynchronous is substantially slower than synchronous communication; the equipment required for asynchronous transmission is, however, simpler and less expensive.

Asynchronous communication is usually best suited to environments in which devices transmit and receive only sporadically; synchronous communication is best suited for continuous transmission at high speeds. A shop floor data collection system, for example, can communicate with its data collection terminals via asynchronous

lines. Communication with the host computer can use a bisynchronous (binary synchronous) line, a type of synchronous communication designed for high-volume, direct computer-to-computer applications.

Communications protocols can permit only one device to transmit at a time (half-duplex communication) or both devices to transmit simultaneously over separate wires (full-duplex communication). Bi-sync communication is always half-duplex.

ASCII and EBCDIC. The two methods of representing the characters understood by humans in the binary code used by computers are ASCII and EBCDIC. Any network can carry either ASCII or EBCDIC messages, but the devices on the line can understand only one of the two. (Most vendors use ASCII; all IBM equipment, however, is EBCDIC. To be plug compatible with IBM, equipment must be EBCDIC.) Conversion equipment can be used to permit ASCII and EBCDIC machines to communicate, but converters are an additional network expense.

Error detection is also part of most link protocols. On most networks, electrical interference frequently results in transmission errors. Since error detection and correction are cheaper than the heavy shielding required to prevent errors, essentially all computer communications involve some detection and correction scheme. Most of the numerous error-detection methods can detect between 80 and 90 percent of the transmission errors. Combining several methods raises overall reliability to acceptable levels. Most error detection and correction are performed by purchased hardware.

Network and Transport Protocols

Networks can be relatively simple (e.g., a shop floor data collection network in which several terminals feed information into a single computer) or very complex (e.g., state-wide electronic funds-transfer systems in which hundreds of devices, including many different kinds of terminals and mainframe computers, are linked).

Routing. Some networks broadcast all messages to all points and depend on each device to identify and act on only those messages intended for it. Other networks relay messages through regional processors with each regional processor identifying the ultimate destinations of the messages and deciding how to route them. Practical and effective routing schemes are of crucial importance in designing an efficient relaying network.

Message Packets. Networks sometimes divide messages into standard-size packets and route them through the networks for reassembly into the complete messages at the destinations. These packets increase network efficiency because the packet length is fixed and the need to annotate each message with its length is eliminated. An

efficient method is needed for subdividing messages and reassembling them in the correct sequence at the destination.

Token-Passing Techniques. Networks that permit only one device to transmit at a time sometimes use token-passing techniques. First, a transmission sequence is defined. As each device completes its transmission, it sends a signal to the next device in the sequence, giving it the go-ahead to transmit. Although token passing is a simple and easily understood way of preventing transmission collisions, the time it requires diminishes network capacity.

Session and Presentation Protocols

Session protocols include the methods and techniques used to connect and disconnect network devices. Even permanently connected networks usually require connection and disconnection logic to allow for device installations and removals. Some networks, such as central time-sharing systems, use multilevel connection and disconnection routines in which users must sign on to the network and separately sign on to the time-sharing service. Session protocols also include logic to reconnect after a line failure.

Security Codes. Networks that involve security codes require security logic at the session (and possibly at the presentation) level of their protocols. (Network security is a complex topic beyond the scope of this article.) Security protocols can include passwords for sessions, applications, programs, and/or data. Encryption and decryption of data may be useful.

Transmission-Time Restrictions. Some networks specify a maximum transmission time. Baseband networks, which permit only one user at a time to transmit, can assure all users of a minimal level of access to the network by restricting each device to a preestablished length of transmission time.

Data Compression. Data compression techniques reduce transmission time without sacrificing information content and effectively increase network capacity with no increase in cost. For example, if a manufacturer's part number always contains a dash in positions 4 and 9, the network can specify that these characters be deleted by the transmitting device and reinserted by the receiving device. Word processing networks can benefit from brief codes used in place of common phrases.

Application Protocols

The highest level in a communications protocol involves the programs themselves. How, for instance, does the shop floor minicomputer communicate the completion of an order to the computer that controls the finished stock and shipments? The minicomputer's message usually contains the following:

- The finished stock computer's address, which is by the network for routing and by the finished stock computer for message identification.
- A code (sometimes called a transaction code) that identifies the meaning and content of the message. For instance, code "ABC" might identify the shipment of an order from the shop floor to the finished goods stockroom. When the finished stock computer receives a code ABC message, it knows that the seven characters immediately following the code represent the order number, that the next 12 represent the part number.
- The data itself, which in this case includes the part number, quantity completed, and other information such as the completing department, the inspector's name, and the order number.

When the shop floor computer enters its message into the network, several things can happen, depending on the design of the network. In one scheme, the network controller attached to the shop floor computer reads the destination code and determines the transmission line. It can add error-checking characters to the message and then send it to its modem over a short connecting cable. The modem converts the message from digital to analog and adds error-checking information.

The message then travels over the network, possibly passing through telephone company repeaters and over microwave and/or satellite links until it arrives at the end of the line and is received by the finished stock computer's modem. This modem converts the message back to digital form, verifies that the message is correct according to its error-checking routines, and passes it to the stock computer's network controller. The network controller performs additional error checking, and passes the message directly into the I/O port of the finished stock computer.

HARDWARE ACCEPTANCE TESTING FOR SMALL COMPUTERS

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PROBLEMS ADDRESSED

Unlike large computer systems, small computers are sold through distribution channels ranging from software houses to computer stores. These computer systems are often assembled with components from various hardware and software vendors, which sometimes results in a system that is unacceptable for the user's application. Consequently, careful consideration of the computer system's intended use and of its specification and acceptance testing is necessary.

Unfortunately, however, written detailed specifications accompanied by a request to bid are uncommon unless the user is buying in large quantity. Small computer systems have relatively low prices and corresponding profit margins that preclude a local computer store, for example, from preparing detailed written bids in response to such specifications.

The solution to this problem is twofold: The hardware and software features important to the user's applications must be identified. Key hardware features are outlined in this article. Those hardware and software features most important and critical to the applications intended for the machine should be evaluated before purchase. Typically, this is easily accomplished, because small computers are generally available for observation, testing, and benchmarking. Furthermore, most applications software consists of generic application packages that can be demonstrated and benchmarked. Acceptance testing of the most critical functions thus can be performed before selecting a particular hardware and software system, leaving very little to be performed after system delivery. This article discusses the critical characteristics of each hardware system component and its related acceptance testing.

GENERAL SPECIFICATION AND ACCEPTANCE TESTING

Five general categories of hardware specification and acceptance testing are important to a small computer system.

Software Compatibility

The hardware specified should be compatible with the selected

combination of application software and software operating system should be specified.

Potential for Expansion

A hardware system whose capacity and capability for future expansion is compatible with selected application software should be specified. Capacity limits that must be determined and checked include the following.

Speed. Whether the processor is sufficiently fast to execute the selected application programs in a reasonable time should be determined. This speed requirement cannot be posed in terms of raw computer speed; instead, it must be evaluated relative to the actual application software packages to be used. A limitation caused by speed manifests itself in several ways:

- An application involving excessive computation may simply take too long to be useful (e.g., certain complex spreadsheet planning applications).
- An application may require frequent access to data recorded on diskettes whose access time may be too slow to permit effective use of the application.
- An application requiring transmission of data to or from another computer may be unacceptable because of a limit on the rate at which data can be transmitted.
- If the system has multiple users, the evaluation should include the effects of concurrent use by the contemplated number of users.

Internal Storage Capacity. It is important to determine whether the capacity of internal storage is sufficient to support the selected operating system and applications software. Again, this requirement is tied to the particular application packages to be used with the system.

In addition, internal storage expansion capability must be sufficient for anticipated future applications. Many small (8-bit) computers cannot be expanded beyond 64K bytes of primary storage. Others (most notably the 16-bit computers) can expand to 512K bytes or more. A need for future expansion of primary storage would arise only if an application required a larger primary storage or if future plans included multi-user operation.

Secondary Storage Capacity. Whether secondary storage capacity is sufficient to support the necessary libraries of programs and the application files should be determined. Secondary storage consists of both disks and diskettes; capacity of these devices varies considerably according to computer system. The capacity requirements of all planned applications must be added to determine total secondary storage capacity required. Two aspects of this capacity should be separately evaluated.

- The programs and data files that must be simultaneously available should be determined. Online disk and/or diskette capacity need only be sufficient for this requirement. For example, if word processing and accounting applications will not be carried out concurrently, different diskettes can be used for the files and programs of each application, thus relaxing the overall secondary storage requirement. Most hard disks are not removable and the files for all applications must be simultaneously present.
- Future expansion of existing applications and purchase of others and their potential file space needs should be considered. It should be ensured that either existing disks and diskettes can be upgraded to have greater capacity or that additional disks and/or diskettes can be added to the system.

Warranty and Maintenance

For any hardware system considered, the type of warranty and maintenance service needs should be specified and their availability checked. Various maintenance plans are available for small computer systems. Alternatives range from contracts that cover maintenance on a fixed-annual-cost basis to simple time-and-materials charges for individual repairs. Maintenance may be available on-site and/or on a carry-in basis. Maintenance may involve actual repair of equipment or replacement by an equivalent unit; the latter is very important in assessing a hardware system. A maintenance contract that replaces faulty hardware with an equivalent system enables a quick return to use. Equipment repair can result in delays, depending on the nature of the problem and the availability of adequately trained repair personnel.

If the small computer system consists of modules purchased from separate sources, all maintenance may not be available from a single source. For carry-in maintenance contracts, this may not be a problem. In any case, the suitability of a single or multiple source for maintenance should be investigated before committing to a specific computer system.

Costs vary considerably depending on the particular hardware system and type of maintenance plan selected. If the system depends on the skills of the maintenance staff, it is necessary to evaluate the competence and completeness of the maintenance offered; this includes number of people, their training, and the availability of spare parts from inventory. Recommendations from other users regarding the hardware being considered are invaluable, as is discussing their experiences with the equipment vendor and maintenance supplier.

Environmental Considerations

The environment in which the small computer will operate should be specified, and whether warranty and maintenance contracts permit operation in that environment should be verified. Most environments in which small computers are used are compatible with war-

rency and maintenance constraints regarding temperature and humidity limits. Exceptions occur, of course, and must be carefully checked. A more severe environmental constraint is the computer's electrical supply. Warranty and maintenance contracts often require that the equipment be operated on a separate electrical line to preclude interference from other equipment. Any equipment that places momentary heavy loads on the power lines (e.g., motors starting) play havoc with small computer systems. Moving small business computers into a business environment may cause a problem by necessitating special isolated electrical lines.

Some small computer systems are especially susceptible to high-frequency electrical disturbance, which often occurs around such office machinery as copiers and results in voltage "spikes" and "droops" on the power lines. Although short in duration, spikes can have two effects on small business computers. They can cause failure of sensitive electronic components if the computer system power supply is not properly filtered. They can also result in momentary errors in computer operation, which can cause a running program to fail or err with an attendant loss of data or files. It is important to determine whether the hardware system being considered is susceptible to such transients; if so, the specifications should include some form of a filter for the electrical power line. Such filters are very low in cost compared to the cost of recovering from a transient failure.

The small computer's physical packaging may also be important from an environmental standpoint. For example, some devices (diskettes in particular) are added to small computers by connecting physically separate devices to the computer; this results in the small business computer system consisting of numerous separate devices with a tangled mess of cable. Motion-sensitive disks are another related consideration because they can fall out of alignment when movement or vibration occurs. As a result, a small computer system that must be moved occasionally could pose a problem from a maintenance standpoint. Physical packaging of systems and associated problems can be evaluated before consideration and purchase.

Communications

The requirements for communications between small computers and other systems should be specified, and the adequacy of hardware support of this communication should be verified. Although support of communications with other computers is usually a software function, several situations warrant hardware support. Communications between computers is an area with a huge growth potential. Several areas of communications requiring hardware support should be considered.

Asynchronous Connection to Another Computer through a Modem. Such hardware support is the most common and is usually available for all speeds likely to be desired. It is necessary only to determine that the hardware devices and speed ranges of up to 9,600 baud are available.

Synchronous Connection to Another Computer through a Modem. This form of communication hardware support is far less standard and must be checked carefully to ensure compatibility with intended applications. Applications range from use of the small computer as a means of transferring files to and from remote DP computers (RJE communication) to use of the small computer as a terminal to a DP system (e.g., an IBM 3270 terminal emulator). In both cases, a combination of special hardware and software, which is not available on all small computers, is necessary.

Connection of Multiple Small Computers into a Local Area Network for Sharing Programs and Data Files. A local area network (LAN) involves high-speed communications with special protocols and requires special interface hardware at each small computer as well as special software to support the communications. This form is currently the least common but is expected to become widely used in the future. Its need arises in businesses that use multiple small computers and that must communicate data files to specific users and permit results produced in one machine to be used elsewhere. Little standardization has yet occurred in this area.

The previous hardware considerations can be evaluated before system purchase and thus do not require acceptance testing after delivery. They are, however, exceedingly important to the success of a small computer system and should be satisfied by the small computer system that is selected.

ACCEPTANCE TESTING FOR INDIVIDUAL HARDWARE COMPONENTS

In most cases, system testing is carried out prior to purchase because of the general availability of software packages and the necessity of testing them using the I/O devices with which they are to be used. It should be emphasized that all such tests should be carried out on a configuration identical to that to be purchased. Individual hardware units must also be acceptance tested. Each hardware module of the small computer system is discussed in the following sections from an acceptance-testing standpoint.

The Processor Unit

The heart of the small computer system, the processor is usually packaged in a module with the primary power supply, primary memory, and all I/O interfaces (i.e., electronic plug-in boards that permit the connection of specific devices to the computer). Five aspects of the processor module must be acceptance tested before purchase.

Maximum Primary Storage. The maximum primary storage that can be supported by a processor is a characteristic of the processor itself; however, in small computer processors, the total potential is not always available to the user. The maximum primary storage

available for the computer being considered should be determined. This represents the capacity available for future expansion if the need arises.

Capacity Limit. In order to add more memory or any device to the computer, slots must be available in the processor module into which the boards can be plugged. The number of slots available is another important capacity limit and must be determined prior to purchase. In particular, the configuration of devices proposed for the small computer leaves a certain number of slots available for expansion, which must be shared among additional primary storage and added devices.

Expansion Capability. A low limit on the number of slots available for expansion is common in small computers, because this limits the cost of the processor module itself. If future expansion (e.g., more devices, multiple users) is planned and if the number of slots is insufficient, the availability of an expansion module, which connects to the processor module via a cable and contains additional empty slots for expansion, must be ensured. Furthermore, the constraints placed on locating items should be determined (e.g., primary, diskette, and disk storage within the primary and/or the expansion module). In all cases, the objective is to determine the system's capacity limits prior to purchase.

Speed. Although 16-bit processors offer the potential for increased speed, it is not always realized in small computers. If processor speed is important, it must be checked before purchase. An internal clock is used in all electronic computer circuitry; its speed determines the speed of computation. Generally, clock speed may vary for the same microprocessor (i.e., up to four times as fast) and produce a corresponding change in speed. Furthermore—and quite frequently in practice—the 16-bit microprocessor may not run faster than similar 8-bit, processor-based computers. Because the clock speed cannot be changed by the user, the only alternative is to predetermine if it is important.

The real measure of computer speed, however, is within the environment in which the machine is to be actually used. That is, the net effect of raw computer speed, operating system efficiency, I/O speed, and the efficiency of the actual application program is important. Therefore, in most cases, it is necessary and sufficient to check the speed of response of the small business computer with the desired applications running on a configuration identical to what will be used.

Input/Output. I/O devices are connected to the processor in two basic ways: direct memory access (DMA) and character-by-character (i.e., serial). DMA I/O is much faster, involving a block of characters transferred from a device (e.g., disk or diskette) directly into primary

storage or vice versa. Almost all computers use DMA for both disk and diskette I/O; this must be checked, however, because the high speed associated with DMA is crucial for most business applications involving much transfer of information to and from secondary storage. Because it is difficult to test business application packages in advance with large files (it is difficult and time-consuming to create the test files), the effect of slow I/O may not be apparent in running the application package. The vendor's literature may be useful in verifying the use of DMA for crucial devices.

If the small computer system is to be used with a range of nonstandard devices (e.g., for laboratory instrumentation), the availability of one of the industry-standard I/O buses—for example, the IEEE 488 (S-100) or IEEE 498—is important. Most instrumentation devices are available with interfaces to these standard buses. In addition to verifying that the standard bus hardware support is available, it is important to verify that corresponding software support is available in the selected operating system. As with all other prepurchase acceptance testing, there is no substitute for seeing the actual operation of such features that may be crucial to the computer system's success.

An interesting development is the advent of dual processors in recently introduced 16-bit small computers. The 16-bit processor is the system's primary processor. A second processor (usually an 8-bit) is provided for two purposes: it handles all I/O for the computer, thus enabling the 16-bit processor to handle the application itself, and the computer can be operated in a mode in which only the 8-bit processor is used, thus permitting the computer to run any software available for that processor. Typically, the 8-bit processor is used to run an operating system such as CP/M, which has been used for many years and for which there is a wealth of application software. The 16-bit processor is then used for new applications, thus providing the vendor with a bridge from 8- to new 16-bit processors without requiring the complete regeneration of all applications software for the newer processor.

If use of dual processors is contemplated, it is important to verify that the applications software functions properly and adequately on the system before purchase.

Acceptance testing of the processor after delivery must be limited to verification that the hardware is actually functioning properly. This should be carried out with several sets of tests.

- The vendor's diagnostic software should be used to verify correct system operation. Diagnostic software is important not only for acceptance testing but also for future maintenance. When a problem is suspected, it can be verified by using such software, which generally limits the problem to a specific module (e.g., processor, keyboard, display). Only that module need be returned to the vendor for service.
- The computer system and the operating system provided by the vendor should be exercised. Usually, the vendor supplies a detailed set of instructions for starting the system, loading the op-

enting system, backing up the software provided, and so on. All these steps must be followed during acceptance testing. In particular, such operation system utility functions as formatting, copying, and verifying contents of disks should be exercised to determine proper functioning of the hardware and software combination.

- These performance tests should be repeated after purchase using the combination of actual system configuration and application software. This acceptance test also ensures that the delivered software has been configured correctly for the delivered system, and that all devices have been properly cabled to the computer system.

The Keyboard

The keyboard is the most important human-machine interface and its significance should not be underestimated. Although one vendor may offer no choice among keyboards, different quality keyboards are available from other vendors. It is necessary to perform keyboard acceptance testing before purchase. The following must be considered.

Layout. The keyboard should conform to the standard QWERTY layout to permit touch typing; this by itself, however, is not sufficient. Layout of keys on the keyboard must be checked by a typist. For example, one vendor displaced the left shift key approximately half an inch from its normal position, annoying touch typists and resulting in errors. Such arrangement of keys is usually caused by the introduction of special character keys that do not appear on the typical typewriter keyboard. No standards have been established in this area; thus, careful evaluation of the keyboard is necessary. Generally, the best keyboards adopt the IBM Selectric keyboard style, which is acceptable to most typists. Special character keys are then arranged around these keys. A type of keyboard that offers higher input rates with a completely different layout is the Dvorak style. The tradeoff between ease of use and retraining time, however, may outweigh the benefits of the change.

Feel and Sound. Keyboard feel and sound are also very important and must be evaluated by a typist. Keys should have concave upper surfaces for a comfortable finger fit. Physical movement of the keys when pressed should be discernible to provide positive feedback to the typist. Membrane keyboards lack this tactile attribute and should be accepted only after testing with the actual applications. Audible feedback is equally important. Some keyboards provide an audible mechanical sound when the keys are pressed; others generate the sound electrically and provide control over its volume level.

Special Character Keys. Special character keys are widely used on small computer systems. They vary from special printable characters that do not appear on the usual typewriter keyboard to special keys

called function keys whose purpose is defined by each program that uses them. Such keys are very useful in simplifying communications between the operator and the application programs; however, their physical appearance and layout must be evaluated for convenience, understandability, and ease of use.

A separate keypad for entering numerical information is also a common feature and useful for applications involving a great deal of numerical data entry. Some keyboards define multiple use of such keys by the use of locking or control keys; thus, when not used for the primary purpose, the key can be used for another. For example, many keyboards alternately use the numeric keys on the separate pad as cursor control keys. Prior to purchase, a typist should check for how natural the use of alternate key definitions is. A poorly designed keyboard can greatly frustrate the user.

Separate Keyboard. A keyboard that physically can be separated from the computer is useful. Such keyboards connect via a cable to the processor module and allow the placement of the processor, display, and keyboard to suit the operator's comfort and convenience.

Programmable Keyboard. A programmable keyboard is another useful feature that can simplify use of application software. The programmable characteristics can be a function of the keyboard itself or the operating system supporting the computer. In either case, these keyboards permit redefinition of the keys' meanings, thus allowing both function and special keys to assume meanings appropriate to a certain application program. In some cases, a key can be defined as a sequence of characters, which greatly simplifies entry of common information.

The Video Display

The video display is also important to the small computer system user. Unlike the keyboard, alternative displays are often available for use with a specific system. These different displays offer varying quality and features. The following characteristics should be evaluated and acceptance tested before display purchase or specification.

Screen Size. Screen size—both physical and in terms of display layout—must be evaluated for acceptability. Alphanumeric displays generally show 24 or 25 lines of 80 characters each. Using a display with fewer characters per line is frustrating, because it requires frequently shifting the display left and right to see the portion of lines that cannot be displayed on the screen. Because most application programs assume an 80-character width, it is difficult to modify software to use a display with less width. Some application programs assume a display width equal to that of a line printer (132 characters per line), thus conveniently displaying any report that can be printed. Most displays, however, do not support such line widths, unless an alternate character set that is physically smaller in size is used.

Others allow the user to scroll the text left or right to view these long lines, 80 characters at a time. Display appearance must be evaluated by the system user prior to purchase.

Special Characters. The display's ability to show special characters in a readable form is also important for many applications, particularly word processing. Thus, descenders for such characters as *p* or *q* should be displayed below the line for legibility. Combinations of characters are also often desirable on a display. For example, a word processing program should be able to display underlined text; most displays do not permit this. Both upper- and lower-case letters are necessary for almost all applications and should be a prerequisite for any display. Similarly, standard variations of displays (e.g., text highlighting, blinking cursor, reverse video) should also be available. All contribute to the display's appeal.

Character Appearance. The physical appearance of the screen characters and the display itself should also be evaluated. Characters should be sharp and in focus without wavering on the screen. Character lines should be straight. Extra spots on the screen, which indicate internal electrical noise, should be absent. The use of black characters on a white background and amber characters on a black background in monochrome displays is increasing; such contrast is easier on the eye. Screen reflection must be controlled either by coating the display, shielding it from overhead lights, or using a polarizing screen.

Physical Positioning. Proper physical positioning of the display facilitates its use. This includes either physical horizontal movement of the display (a simple task if the display is separate from the processor module and the keyboard) or ability to rotate the display. Equivalent vertical rotation is also important. The viewing angle of the display varies according to the table on which the display sits and the operator's height. Operators that wear bifocals or trifocals, for example, have to view the display through the reading sections of their glasses. A display at eye level then implies that the operator has to tilt his or her head back to view the display properly. Such considerations are very important to the user and can be evaluated only by having the user sit in front of the keyboard and display in an environment closely resembling the actual one in which the system will be used.

Graphics and Color. Graphic and color displays are becoming more common in small computer systems. The rate at which graphics are produced, their appearance, and the color range must be evaluated prior to system specification or purchase. Moderate and high resolution graphic systems differ significantly as do their prices. Color and graphics should be evaluated using the specific application programs that produce the graphic displays. Display responsiveness is facilitated if the display is memory mapped. This means that the

application programs write the characters or graphics to be displayed into a special section of memory, which is automatically displayed by the hardware and updated on each video scan of the display. More expensive graphic displays provide more than one such area of memory, thus allowing the display to be switched back and forth among several displays without wait time.

Secondary Storage

Almost all computer applications rely heavily on information stored in files on secondary devices (i.e., disks and diskettes). A computer's internal memory is not suited to long-term information storage, because it is too small and highly volatile. Most of the internal memory is used for storing currently executed programs; the remainder is used for storing the small amount of data currently being manipulated. As mentioned previously, acceptance testing involves the determination of the amount of secondary storage that must be online and available to application programs.

The most common media for long-term data storage on small computers is the diskette (also called the floppy disk). The primary advantage of using diskettes for storage is that they are inexpensive (about \$5.00) and can contain up to 1.2 megabytes of information for several years. They are also a removable media; thus, although a system has only one diskette drive, as many diskettes full of data as desired can be stored with only one at a time directly accessible to the computer.

There are currently three sizes of diskettes: 3-1/2-, 5-1/4-, and 8-inch diameters. The 8-inch is the original; it holds the most data (up to 1.2 megabytes) and also provides the fastest access to it. The 5-1/4-inch diskette provides up to 0.6 megabytes of storage and is typically somewhat slower for data access. The primary advantage of the smaller diskette is that the drives are 15 to 30 percent lower in cost. The recently introduced 3-1/2-inch diskettes are not yet fully standardized in diameter and remain untried.

Diskettes can be formatted in many ways. For example, there are hard- and soft-sectorized diskettes, single and double density, single- and double-sided, and sector sizes of 128, 256, 512, and 1,024 bytes. Any one of these factors can make a diskette totally incompatible with a diskette written on another system or even written on the same system but with different parameters. Furthermore, a diskette written on one system may still be unreadable on another even though the parameters match if the software encoding of the information is not identical. The resulting confusion is only a problem if the data is likely to be moved from one system to another.

If such data movement is a consideration, 8-inch diskettes should be specified; they are currently the only ones that adhere to standard recording techniques. Even if the 8-inch diskette is chosen, however, the physical formatting particulars and the software encoding must be compatible. Software encoding is likely to be a problem if two dif-

ferent machines use different operating systems. This in turn favors such operating systems as CP/M and UNIX that can be found on many machines. This is a thorny issue and it is advisable to try transporting data between machines to prevent being locked into total incompatibility or to eliminate the need to write conversion programs.

Although diskettes and disks are generally reliable, loss of important data can occur if the disk surface is scratched or otherwise unreadable. Insurance against data loss is possible by periodically backing up the data on another diskette. Thus, if one diskette fails, the other will be available. This backup process is easily accomplished with two diskette drives—a software utility program is used to read one diskette and write the same data on the other. Having two diskette drives is highly recommended, as is the periodic backup of diskettes containing vital data. Unfortunately, because diskettes are usually so reliable, the need for data backup is often overlooked. Invariably, a diskette fails when least expected, re-creating the data can be very time-consuming and sometimes even impossible.

The speed of a small computer is greatly limited by the time it takes to access data from a diskette. A disk allows much faster access to data and offers much greater storage capacity (typically several megabytes). Most disks are nonremovable, however, and thus must be used somewhat differently than diskettes. The most frequently accessed files are usually stored on the disk; the remainder can be kept on diskettes. Diskettes are still necessary not only for storing less frequently used files but also to back up the disk contents against hardware failure. Disk backup may be much more complicated, because many diskettes may be needed to back up the contents of the larger disk. Although disks are generally more reliable than diskettes, backup is still necessary.

The following acceptance tests should be carried out for disks and diskettes.

Operating System Support. Before specifying or purchasing any disk, it should be ensured that the operating system selected actually supports the disk. This includes the ability to maintain program and data files on the disk and to boot, or start, the system from the disk.

Support of Alternate Sectors. Unlike diskettes, which can be discarded when a portion of the surface fails, disks are usually nonremovable and probably not replaceable under a maintenance contract. If a small part of the surface (i.e., a few sectors) becomes unusable, it is necessary that the operating system support the use of alternate sectors; that is, it should log the fact that certain sectors are bad and either ignore them or replace them with good sectors located elsewhere on the disk. This capability is not always available and must be checked before disk purchase.

Diagnostic Software. After delivery, the diagnostic software should be run on each diskette and disk drive. This diagnostic soft-

user should check the proper functioning of the secondary storage units in general as well as the proper rotational speed and alignment of read/write heads. Continued maintenance of disk and diskette drives is required to check speed and head alignment. Diagnostic software for this purpose should be included in the system's specification and used for acceptance testing after delivery.

Proper Operation. Proper operation of each diskette drive and the diskettes purchased with the system can be ensured by formatting diskettes in each drive, loading them with data, and verifying the correct storage of information on the diskette as well as its readability in drives other than the one in which the diskette was created. Operating system functions (e.g., format, copy, backup, and compare) for these operations are available. They will check not only the diskette drives but also the actual diskettes purchased. Unfortunately, experience indicates that some manufacturers' diskettes work well with some diskette drives but not with others. The computer supplier's recommendation for a source of diskettes should be heeded.

The Printer

Hard-copy output is necessary on all small computer systems; it is also one of the most difficult capabilities to provide adequately. The situation is complicated by the possible need for nonstandard forms sizes, preprinted forms that differ according to application, maximum size needed, and quality, speed, and volume of printing required.

Printers are divided into two general categories: serial (one-character-at-a-time) printers, which print at the rate of 15 to 150 characters per second or about 20 seconds to 3 minutes per page, and line (one-line-at-a-time) printers, whose speed starts at the upper limit of serial printers and can be at least 10 times faster. Line printers are expensive (approximately \$7,000 for a low-quality printer) and are rarely used with small computers. (Serial in this context does not refer to the method of data transmission between computer and peripheral, which can be either serial, parallel, or 20-mA current loop (TTY). The faster line printers, however, typically employ parallel communication.)

Serial printers are further divided into two categories: matrix printers and letter-quality printers. Matrix printers produce their characters using a grid of dots (5 x 7 for less expensive printers, 7 x 9 for better models). The quality of print is not adequate for most word processing applications. Letter-quality printers commonly use a fully formed character for printing. Types of printers include the IBM Selectric ball, the Diablo daisy wheel, and the NEC thimble. Letter-quality printers are usually limited to printing speeds of 20 to 50 characters per second. These printers usually offer either pica or elite type (10 or 12 characters per inch), changeable fonts, and print lines that vary in length from a minimum of 80 up to 132 characters.

Matrix serial printers are often selected if graphic characters are desired. They usually provide multiple character sets, a variety of graphic characters, and choice of character size, number of characters per line, and vertical spacing of lines.

Acceptance testing of printers must take place prior to purchase to ensure adequacy for the intended applications. The printer is often an integral part of an application program and must be evaluated in conjunction with that particular program. Generally, the following should be considered.

Application Program Needs. Printer selection should be based on the application program needs, including the quality and speed of printing required. The printer should be evaluated using the actual application program to ensure that proper printed output is attainable.

Operating System Support. The availability of operating system support of the printer that is selected should be verified. Small computers may permit connection of more than one printer. The operating system should direct printing to the appropriate printer without requiring modification of applications software. Of importance here is a peculiarity: some printers automatically insert line feeds whenever a carriage return is transmitted. Such a printer precludes use of a carriage return and then overtyping the line (e.g., for underlining purposes). Some operating systems assume that a line feed is required after a carriage return and insert it automatically; thus, a printer that does not need the extra line feed causes all printed output to double space. Such troublesome characteristics of printers and operating systems are extremely difficult to eliminate or fix after purchase and thus should be eliminated by selecting the proper computer, applications software, and printer.

Diagnostics. Most printers include built-in minimum diagnostics that check proper operation of the printing mechanisms and interface electronics. These diagnostics should be checked both before purchase and as an acceptance test after purchase. Often, small problems (e.g., alignment of print head or ribbon) can be checked with such software, saving a maintenance call. If processor diagnostics exist to further check out the printer (e.g., print standard lines for total checking of printer operation), it is advantageous to also use them as an acceptance test.

Noise Level. Printer noise can be a problem. The noise level should be checked prior to system purchase, which may be difficult because the large areas within a small-computer store do not duplicate the small office environment. The availability of noise-suppressing hoods or enclosures for printers should be verified if noise presents a problem.

Modems and Remote Computer Connections

Modems are devices for transferring data from one computer to another over a telephone line. They connect to standard serial interfaces on small business computers and generally do not cause a physical interconnection problem, because the interfaces are built to the EIA RS-232C standard. Most modems for small computers transfer data at a rate of 37.5 characters per second (300 baud); some have a rate as high as 1,200 characters per second (9,600 baud). Almost all interfaces support the low data rates and conform to the particular Bell signaling protocol. The following characteristics should be checked.

- * Whether operating system support (or a separate communications program) exists for communication with a remote computer should be verified. This communication can be either for the purpose of acting as a terminal or for transferring files.
- * If the computer is to be used in an environment where the host computer calls the remote user, the automatic-answer feature on the user's modem and corresponding support in the operating system are very desirable and should be checked prior to purchase.
- * Automatic dialing of remote computers by the user is available on some modems and should be checked for compatibility and support by the operating system.

Other Devices

Other devices commonly connected to small business computers include light pens, plotting devices, digitizing tablets, analog and digital signal data acquisition devices, and magnetic tape units. Generally, it is necessary to check that hardware interfaces for the computer considered do exist and that software support through the operating system or separate programs is available. Each case must be considered individually. Usually, however, it is wise to consider carrying out any acceptance testing of such devices and their software prior to specification and purchase of a computer system; obtaining custom hardware and software support of most small computers can be costly and difficult.

CONCLUSION

Both general hardware-related problems and those unique to small computer systems can either be avoided or resolved early if the computer's features are carefully evaluated and acceptance tested. Too often, the small computer is initially effective but soon outgrows the application because of the need for access to data available only in the centralized computer facility. If the small computer cannot function as a terminal to access necessary data, it becomes ineffective and unused or requires expensive custom support. This article discusses hardware considerations and related acceptance testing to avoid this outcome.

USING MICROCOMPUTERS FOR MATERIAL REQUIREMENTS PLANNING

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MICROCOMPUTERS AND MICROCOMPUTER APPLICATIONS

Computers are generally classified in three categories: mainframes, minicomputers, and microcomputers. The IBM 3030 and 4330 series computers, for example, are mainframes; the IBM System/34 and System/38 are examples of minicomputers; and the IBM Personal Computer, the Apple Computer Inc. Apple II, and the Tandy Corp. Radio Shack TRS-80 are examples of microcomputers.

Microcomputers generally offer from 32K (thousand) to 128K bytes or characters of processor memory and one or two diskette drives, each with a 150K- to 300K-byte storage capacity. Larger-capacity hard disk systems, called Winchester-type disk drives, are increasingly available, thus making microcomputers effective for a wider range of business applications. In business applications microcomputers also need printers. Typically, dot matrix printers capable of printing 80 or 132 characters per line at 80 characters per second are used. The typical cost for business microcomputer systems ranges from \$2,000 to \$7,000 for hardware and from \$200 to \$7,000 for software programs, depending on the applications.

Use of microcomputers in business is growing rapidly as managers discover more uses for them. Software Arts Inc.'s VisiCalc, the modeling and forecasting spreadsheet program, and various word processing packages are already popular applications that have enhanced planning and correspondence activities in small businesses. Material requirements planning (mrp) is a business function that requires a computer because of the massive amounts of data that must be routinely stored and manipulated. Only recently, however, with the availability of Winchester-type disk drives for microcomputers, has computerized mrp become feasible for smaller manufacturers who could not afford the larger computers. This article discusses the use of microcomputers for running mrp, describing the functional and system requirements, startup, and methods for evaluating the feasibility of using a microcomputer.

mrp FEATURES AND ENVIRONMENTS RELATIVE TO MICROCOMPUTING

There are basically three types of material requirements planning systems: standalone mrp, closed-loop mrp, and mrp as a component of manufacturing resource planning (MRP²). Standalone mrp merely schedules the timing and quantity of replenishment orders for both purchased and manufactured material. Closed-loop mrp adds capacity evaluation techniques to provide feedback to the system about the physical capability of doing what the schedule dictates. MRP adds another function to closed-loop mrp: the ability to track the financial impact of daily business operations and decisions. The costs of components are monitored and automatically accumulated in the assemblies to produce a continual picture of the cost of the final product. Purchase commitment figures are also supplied in time-phased format as well as work-in-process costs and the current and projected value of inventory. With this information manufacturing executives gain firm control of the business and can manage levels of financial commitment while balancing them against expected levels of service to the market.

There is no reason why a small manufacturer or a small division of a larger firm cannot have MRP on a microcomputer-based system. The key is the software, and the package can be designed for MRP if the software designer maintains simplicity. For example, an automatic interface of the financial data from the mrp system and the general ledger system should be avoided. However, costed reports certainly can be produced, and files can be up-loaded to a larger host computer's financial system, or even transferred to another financial package on the microcomputer.

While net change mrp systems appear to have advantages, mrp on microcomputers should operate in the regenerative mode. The regenerative method takes longer because it replans all active parts in the bill of material, while net change replans only those assemblies (and their components) affected by changes. However, the regenerative method presents fewer potential problems to the user. First, because it replans all parts in the bill each week (or as frequently as the generation is run), this method has a tendency to clean up automatically or identify problems that may have been caused by human error. Second, tracing the effect of changes in inventory status is easier with regenerative mrp than net change. Third, the regenerative method is less "nervous." For example, it will not suggest (as net change systems typically do) that a work order, put on a machine in the morning, be taken off the machine that afternoon to favor the recent discovery of some urgently needed part.

Environmental considerations that affect the advisability of using a microcomputer for mrp are the length of the planning horizon and the complexity of the bill of material. The length of the planning horizon is the time from first order of lowest level parts in the bill to shipment of the final product. If it exceeds one year, then only larger computers should be considered. When too many time buckets are

involved in the generation of *mrp* outputs, the microcomputer takes longer than is convenient or reasonable to complete the job. Also, extremely long planning horizons usually indicate the existence of complications that preclude the use of a microcomputer for *mrp*. The Boeing Company, for example, with long lead times for planes costing millions of dollars each and pegged for specific customers, needs a more sophisticated manufacturing system than is feasible even using minicomputers.

If the bill of material is complex, with many features and options such as those in the automobile industry, *mrp* on microcomputers should be considered carefully. Frequently, however, complex bills simply result from traditional methods; with proper training in restructuring techniques, manufacturers can simplify bills and, consequently, processes.

Full-level pegging and assigning quantities to planned orders by economic order quantity (EOQ) should be avoided on microcomputer systems. Full-level pegging produces a report that is essentially a full "where-used" list of the entire bill of material. This report produces large amounts of paper and requires hours to process. A much better method, the interactive single-level pegging, allows level-by-level tracing through the bill of material for specific parent/component relationships. Dynamic EOQ methods such as part period balancing, least total cost, least unit cost, and look ahead, look back assume too much decision-making authority for order quantities. The best method of assigning order quantities on microcomputers is lot for lot. This method allows complete freedom of quantity selection.

The manufacturer who investigates *mrp* on microcomputers must recognize the tendency to overcomplicate *mrp* systems. Extra features, functions, and capabilities detract from a basically simple concept. They can, therefore, degrade performance on the whole system.

Feasibility Guidelines

The following guidelines for maximum system volumes can be used to evaluate the feasibility of a microcomputer-based *mrp* system:

Number of unique part numbers in the inventory	3,000
Number of parent/component relationships	6,000
Number of work centers on the shop floor	50
Number of operations per average work order	100

The more complex the bill of material, the more care should be taken to ensure that the microcomputer system can handle it.

Beyond this list of criteria, general business judgment should prevail. If a company is small enough to manually track the need and timing for replenishment orders, it may not need *mrp*. Despite benefits from the cost roll-up and capacity features, if maintaining the

necessary files comes close to looking like a redundant task, justifying the effort will be difficult. If, on the other hand, late deliveries, work stoppage caused by missing parts needed to complete assemblies, a conviction that inventory investment should be lower than it is, and a general lack of control are a problem, a company would benefit from *mrp*.

Is a particular environment suited to *mrp*? The answer lies not in the physical environment, per se, but in the managerial philosophy. Widely different manufacturing companies experience similar control problems and operational environments. Identical *mrp* systems can work equally well in many environments, yet few companies are convinced that this is true. *mrp* works best in an environment where the bill of material is multilevel and is fairly stable, with few options; in a make-to-stock shop, where large production runs are possible; where the accounting system uses standard costs that do not change often; and where purchased material is easily acquired with short lead times. However, any other manufacturing management system or philosophy would work as well in such an environment. *mrp* becomes invaluable in uncertain environments because nothing else will provide as much visibility and control. But *mrp* will not work in any environment unless the manufacturing manager becomes skilled in its capabilities.

mrp MICROCOMPUTER SYSTEM DESIGN

Software for *mrp* on microcomputers is not yet available in abundance. Although only a handful of packages are available, more will come in the near future. A useful starting point for system design is to evaluate the available software, then let the software determine the hardware, within targeted cost constraints. Such publications as PC Magazine, Softalk, Personal Computing, Creative Computing, and the ICP Software Directory: Business Applications for Microcomputers are good reference sources. Local American Production and Inventory Control Society (APICS) chapters are also a good resource.

Consultants can also help. Again, local APICS chapters know who they are and where they are located. If consultants are used, a careful evaluation should be made to determine whether their philosophy is appropriate. This prevents a company from wasting time arguing operational philosophy and procedure.

Multiterminal Configurations

When considering *mrp* on a microcomputer, the small manufacturer should consider the following questions as a preliminary analysis:

- How many people will participate in the maintenance and operation of *mrp*?
- If more than one person will use the microcomputer, will any functions need to run concurrently? For example, will master production schedule maintenance normally occur at the same time that receipts and issues to the stock room will be entered?

Will purchase orders and shop floor orders need to be maintained concurrently? And will someone want to find where a part is used in the bill of material at the same time that someone else wants to query the stock quantity of another part?

- * If significant use of the system is anticipated, can this use be managed by printed reports and batch updating?

If this preliminary analysis indicates that more than one terminal will be required, then the company must determine how many will be needed. It is important to separate the essential requirements from the enhancements. If, after doing so, the need for more than four terminals is established, then the company's size or complexity is too great for a microcomputer. If four terminals or less seem sufficient, then a multiterminal or shared-disk system is feasible.

Multiterminal systems for microcomputers are among the newest capabilities in the current market. The competition among vendors supplying this market is intense. Prospective users should be careful, therefore, and solicit unbiased, third-party assistance to ensure that requirements are met with shared-disk systems.

In multiterminal systems each microcomputer operates as a complete standalone computer and not merely a terminal. However, each shares a single disk storage system with the other microcomputer units. One of the microcomputers acts as a host computer and needs special software for controlling all access to the disk system. If all the microcomputers connected to the disk system need to access different files simultaneously, the host computer services them one at a time. Only a slight reduction in response time can be detected in the host computer. If, however, two or more of the microcomputers need to access the same disk file at the same time, the system determines which one may access the file, and then issues "device not ready" messages to the others. The requesting microcomputers must keep trying until the one that has access is finished with the file. Competition for access to storage will affect response time, but if no more than four computers are connected to the system, the response time should be acceptable. Furthermore, if users manage to coordinate their requests to the same files, the work flow should not be hampered.

Microcomputer shared-disk system operation is similar to that of large multiterminal computers. A large computer actually does only one thing at a time. Its speed as it services multiple-user requests creates the illusion that tasks are performed simultaneously. However, even a large computer can become bogged down by many simultaneous requests. To avoid excessive response time, shared-disk systems require use of the fastest possible microcomputer, effectively dictating 16-bit microcomputers, which are much faster than the older 8-bit microcomputers.

Hardware Requirements

Even in the small manufacturing company, the amount of data manipulation required for MRP is overwhelming. Each quantity required

in each time period (typically weekly for one year) for each part in the bill of material can be moved or changed every time an mrp regeneration is processed. Depending on the number of parts in the manufacturer's bill of material, the memory requirement of the computer could easily exceed 64K bytes of memory. Such 8-bit microcomputers as Apple II and Radio Shack's TRS-80 II cannot exceed 64K bytes of memory, but the 16-bit machines can have memory of more than 1,000K, or one million characters. As discussed in the preceding section, 16-bit microcomputers are usually faster than the 8-bit microcomputers, and regenerating mrp requires a significant amount of time. It is not uncommon for even the larger computers to take one hour per 1,000 parts for mrp regeneration. Speed is, therefore, very important in the choice of the microcomputer and effectively rules out 8-bit microcomputers as candidates.

Because of their speed and size, the IBM Personal Computer and the Apple III are clearly the most likely candidates for mrp by the small manufacturer. Other computers such as the Altos Computer Systems 9600 and Series 5 systems, and the CBM 8000 systems from Commodore Business Machines are alternatives. An additional consideration is that the IBM and the Apple, already very popular, will attract more software vendors to develop mrp systems. However, any microcomputer with enough memory, hard disk, and good software will handle mrp in a small company.

In general, the micro should have at least 128K bytes of memory to handle the indexes to the mrp files and at least 5M bytes (megabytes or million characters) of disk storage. It should be equipped with a printer that can print 132 characters per line, because many mrp reports require more printed columns than a standard typewritten page can accommodate.

Software Requirements

The software for an mrp system can be written with an interpretive style language processor or a compiler style processor. Execution speed and flexibility are two major considerations.

Interpretive style software runs slower because the language processor must interpret each statement in the program, convert it to machine language or object code, and then execute the statement. A compiler, on the other hand, has already converted all the statements into object code, and therefore produces faster-running programs. Compiled programs are rigid and inflexible, however, and when changes need to be made they must be recompiled. Programs stored in interpretive style are easier to change, thus easier to maintain. Because interpretive systems can always be compiled, however, a logical approach is to acquire an interpretive system and have it compiled if it is too slow.

Operations Considerations

When investigating a microcomputer-based system, the prospective user should look for easy and straightforward file backup and

recovery procedures and require a demonstration of these procedures. The procedures should be easy to perform. The system should be designed on the philosophy that because problems are inevitable, ready solutions must be available.

Automatic security measures are desirable only on the large computers. They are not required on microcomputers, and they will only degrade system performance. The best security, after all, is responsible users and good operating practices.

FINAL CONSIDERATION: THE VALUE OF THE EFFORT

Will it be worth the effort? Aside from the spirit of adventure, the challenge of change, and the desire to outdo the competition, *mrp* on microcomputers is a worthwhile opportunity. Within one year of the first ventured step, management could reduce inventory investment by 25 percent, increase sales by 5 to 10 percent, and improve productivity by 5 to 15 percent. Few techniques currently known have the potential for such a dramatic impact on both sides of the return-on-investment equation. Small manufacturers, with their ability to evaluate new tools and to make decisions more quickly than the average large manufacturer, will become a major market for microcomputer-based manufacturing systems.

Implementing *mrp*, however, requires an especially firm commitment of effort and resources by manufacturers who want to see the project succeed. Change and uncertainty will be introduced to the operation, and this can cause resistance from key people. Frustration will surface as bills of material are structured and restructured until they are correct and as record errors and human mistakes create false starts. But once results are evident and benefits start to accrue, a deliberate, logical work flow will materialize.

MICROCOMPUTER ADMINISTRATION POLICY

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GENERAL POLICIES AND RESPONSIBILITIES

Microcomputers play an important role in the information services provided to an organization, and management must participate in selecting, evaluating, and implementing them. Without comprehensive management or control, acquiring a microcomputer can lead to frustration, confusion, and overspending. With constructive implementation, developed and monitored by key managers within an organization, the microcomputer can become an extremely accessible information resource.

The Illinois Department of Transportation (IDOT) hoped to develop, before purchase and installation, a strategic policy for implementing microcomputers. A policy report was designed to inform IDOT personnel of their responsibilities in microcomputer selection and operation. The policy also outlined the role of key IDOT managers in helping select the appropriate, cost-effective microcomputer hardware and software as well as in developing the role of key IDOT staff in supporting microcomputer hardware, software, and documentation. Under this policy, these managers also are responsible for helping users identify problems after buying and installing microcomputers.

The goal of this microcomputer policy is to help managers become informed consumers in the microcomputer area; this requires the assistance of specific staff members because of rapid technological change, the number and variety of hardware and software vendors, and the price of inappropriate or uninformed decisions regarding hardware or software purchases. The technical support staff should also look at a comprehensive policy of microcomputer integration with word processing equipment, data processing equipment, and other office automation support components.

To help managers and technical support assess microcomputer requests from various departments, an evaluation process should be instituted. It should include, but not be limited to, these topics: administration of microcomputers, hardware and software evaluation and documentation, training of new users, maintenance and support of microcomputers, informational support of users, and necessary customized applications software.

The most important considerations in developing a microcomputer policy are:

- Documenting the new organizational structure associated with the microcomputers
- Examining management's monitoring and control of the new information resource
- Determining the organization's information needs and what the available technology can provide

Management should recognize the microcomputer's potential in planning budgets, making cost projections, and developing financial forecasts and projection programs (i.e., spreadsheet packages). These projections can also be interfaced with graphics programs so that visual presentations can be incorporated into reports. The ability of the microcomputer to perform many functions is another consideration. The microcomputer can be used as a word processor, for example, to support office management functions, enabling managers to develop memos and brief reports without resorting to the typing pool.

Information flow is possible between microcomputers to enhance their flexibility, enabling managers to transmit information by electronic mail; that is, short messages, memos, and documents usually sent via telephone can be transmitted between microcomputers within an organization or across the country. This microcomputer function is very attractive because it eliminates "telephone tag" with other administrators, since such transmissions are fully automated, without operator intervention.

The affordability of microcomputers means that information processing that once could be performed only at certain terminals in selected areas tied into a large mainframe computer can now be performed by any user at a much lower cost. The affordability factor, however, may prompt the purchase of many of these units before a comprehensive policy or plan is set forth. The impact of gross purchases without a strategic plan for implementation can have serious cost/performance consequences.

An important component of the microcomputer policy should be a methodology for comprehensive evaluation and understanding of the microcomputer's primary and peripheral equipment and software. Although managers involved in implementing a microcomputer policy are not directly involved with the daily activities of microcomputer support, they must thoroughly understand the terminology and have a working knowledge of the equipment and software if they are to be effective in dealing with technical staff and vendors both before and after a sale.

ADMINISTRATION

Administrative considerations of a microcomputer policy are subject to change, but typical ones include:

- The selection process

- Examination of lease, purchase, and maintenance agreements
- Review of the necessary consumable supplies to support the microcomputer project
- Examination of security aspects if applicable
- Inventory assignments
- A cost/benefit format for the microcomputers.

The Selection Process

An administrative consideration is examining how a microcomputer or group of microcomputers is requested for a particular area. Complete documentation of the request procedure is necessary to ensure the use of appropriate organizational channels.

In order to assist microcomputer users in the analysis and selection process, IDOT outlined steps for requesting microcomputer services. These procedures aided the IDOT staff in microcomputer selection and also outlined the integration of other data processing and word processing services in specific applications when a microprocessor was inappropriate.

The procedures were designed to maximize the resources of available staff and minimize the time and cost lost through inappropriate hardware/software selections. The procedures are as follows:

1. An individual requests automated services to a specific IDOT bureau. It should be noted that microcomputers were not initially deemed appropriate until an analysis of the user's needs was completed.
2. A form requesting DP services (not specifically microcomputers) is completed and transmitted to the DP manager within IDOT.
3. The form is reviewed by the DP manager and assigned priority in accordance with IDOT's information processing goals.
4. Notification of implementation is transmitted back to the individual requesting information services.
5. The DP manager then meets with the appropriate staff to assign personnel to the user requesting information services.
6. The assigned information processing personnel meet with the user to perform a definition of requirements, using a Warnier-Orr methodology.
7. Upon completion of the requirements and definition analysis, hardware and software requirements are specified by the analysis team.
8. Based on the data obtained through the functional requirements definition, a determination is made to review the equipment before purchase (if the requirements definition indicated that a microcomputer and appropriate software could fulfill these requirements). Supportive information (e.g., an evaluation) is completed with the assistance of the appropriate staff.
9. The user and the assigned analysis staff develop a request for a proposal and outline the minimal functional checklist for the equipment.

10. The user and the information processing analyst review vendor bid submissions.
11. A vendor is selected.
12. The information analysis team and appropriate personnel install equipment.
13. The user is trained off-site through IDOT's information processing section; training at the actual work site with the new equipment is a phased approach.
14. Maintenance and support are maintained on an ongoing basis by the appropriate personnel.

Throughout the request procedure, management judges the information request in light of the analysis of the user's needs and the technology that would best fulfill them, rather than in terms of the equipment that the user wants. Information processing or information requests eventually evolve into combined services of the micro-computer, word processing equipment, minicomputers, and large host mainframes. Therefore, managers assigned to working with microcomputers must confer with others as part of a committee on project requests and implementation, or they must report to higher management to avoid duplicating information services or selecting inappropriate equipment.

Lease, Purchase, and Maintenance Agreements

IDOT wanted a policy on leasing agreements for all its DP equipment because current technology can become outdated so quickly. Unfortunately, microcomputer costs are so low that many vendors do not have any type of lease agreement. Some retail stores do rent and lease equipment; the leasing agreements vary and thus demand a knowledge of specific contractual requirements before any form of lease is entered.

A lease/purchase agreement (i.e., the actual contract) should be thoroughly reviewed before entering into it. This is critical in terms of equipment replacement or service, especially when it is discovered after implementation that heavy use necessitates replacement or repair. Management must coordinate the maintenance staff to replace a malfunctioning unit in the least possible time. This can be accomplished in one of two ways:

- * Because of low microcomputer costs, it is possible for the staff maintaining the microcomputers to have spares at their disposal.
- * A leasing agreement can provide for repair or replacement by the retailer within 24 hours.

The technical expertise of retailers varies greatly. The best insurance for maintenance is having in-house staff with a working knowledge of the equipment and the ability to perform light maintenance. If, on the other hand, the staff does perform such light maintenance, the vendor's maintenance agreement or replacement policy may be voided. It is very important to review warranty provisions in purchase and lease agreements to ascertain how they specify user sup-

port as compared to retail-vendor support; this reduces the chance of voiding equipment warranty through in-house support.

Consumable Supplies

The manager's job in regard to consumable supplies should not deviate from present organizational responsibilities of those in charge of ordering them. Initially, those staff members ordering consumable supplies should be assisted by the manager in the review of recommendations by the vendors.

Consumable supplies include:

- 5-1/4-inch or 8-inch diskettes, the recording medium for the microcomputer
- Paper for any type of printer
- Mailing labels if applicable
- Print wheels if a letter-quality printer is used
- Ribbon cartridges if either a matrix printer or letter-quality printer is used

It is important that the vendor-specified print wheels be used with the letter-quality printers calling for them. The consequences of using subquality print wheels with a letter-quality printer is reduced print-wheel life (which cancels the cost-saving factor). In this case it is wise to consider the vendor's recommendations.

Security

Security considerations vary according to the organization and workstations within it. Organization and user workstation analysis should indicate the security requirements. Managers should ensure prevention of data theft and backups of secure information contained on diskettes; however, the best security for such information is to simply lock up the diskettes and store them where they cannot be accessed by unauthorized personnel.

Some software vendors offer security software that can be used with diskettes; however, the user may fail to understand thoroughly how that security encryption scheme works. If a software maintenance problem points to damaged secure information on a diskette, it becomes very difficult to recover that information. A management consideration regarding security is how to enforce a security policy that is as simple as possible for the users, is not time-consuming, does not establish a whole new organizational structure, and is easy to implement. Extensive security schemes may look attractive because of their complexity, but this may also hinder the user in implementing the new equipment.

Inventory Assignments

Inventory number assignments are necessary when the new equipment arrives but should require no additional staff. A routine organizational structure for assigning numbers should be established. It may be necessary, however, to develop a policy regarding software

inventory assignments. Because a great deal of software is maintained by users rather than at a central repository, management must keep track of software lending between users. Another factor to be considered is the relatively light weight of microcomputers and the peripheral equipment, making them easy to steal. IDOT requires that any room containing microcomputer equipment be locked during designated hours. In addition, no equipment leaves the office without the signature of the appropriate manager.

Cost/Benefit Analysis

IDOT viewed its microcomputer implementation as a cost/benefit because test and management support programs that had been run through a large mainframe computer using telecommunications and time-sharing options could now be operated in a standalone mode. This saved the usage fee for a large host computer that was charged to IDOT.

A more comprehensive analysis format is a cost-avoidance one, in which microcomputers are the option over installing other terminals and enlarging the network tied into a large host computer. Microcomputers eliminate phone and telecommunications costs, CPU time costs, and large vendor terminal costs. In addition, with the implementation of microcomputers as alternatives to word processors, the administrative support staff can be far better used because of time savings with very comprehensive software available to microcomputers; thus, hiring additional programming staff because of the volume of administrative support work is unnecessary.

In the final analysis, a cost/benefit or cost-avoidance analysis is only as good as its developer. The best cost/benefit or cost-avoidance analysis can only give trends or indications of where some of these cost factors may lie. Therefore, management should be aware that the analysis is only a support component of the overall justification for a microcomputer project.

DEVELOPMENT AND TRAINING

A comprehensive development and training program for all individuals associated with microcomputer implementation, maintenance, and support should be incorporated into a microcomputer implementation policy. An educational plan specific to managers and to technical, professional, and clerical or support staff should be developed. Consideration should also be given to those with expertise in using microcomputers or DP equipment; thus, their training can be in the form of self-instruction.

The objective of any development and training program is to acquaint the new user as quickly as possible with the appropriate hardware and software. IDOT recommended two-phased training. The first phase is training with the new equipment outside the user's normal work area. This proves valuable because it gives individuals

time to gain an in-depth understanding of their new equipment before using it. The later phase consists of training tailored to particular user work areas and applications. Management should also be sympathetic to the time that individuals must spend away from their desks during the training period. The cost in time lost through training will be repaid, since this two-phased approach will ensure better use of the equipment in less time.

The technical staff should have a more intensive training program than users. It should involve a thorough understanding of such areas as:

- Microprocessor systems:
 - RAM
 - ROM
 - I/O routines
 - Memory-mapped I/O
 - Chip architecture
 - Bus architecture
- Disk storage
 - Floppy disks
 - Hard Winchester disks
 - Logic assemblies
 - Mechanical subassemblies
- Printers
 - Dot matrix
 - Character impact
- Modems
- Monitors/CRTs
- Operating systems
- Clocking assemblies
- Installation procedures
- Application software
- Maintenance procedures

Education of the technical staff should be continual to increase knowledge in relation to the expanding technology. A plan of professional staff education should specify goals to be achieved through the training process. These goals should address how the new equipment is to be used under the supervision of their respective managers. Implementation should be codeveloped by the professional staff and the microcomputer team assigned to train users.

The initial phase is taught off-site in an area designed by the microcomputer training team; it is an intensive introduction to new hardware and software. The second phase involves the equipment at its permanent work site. The training program should satisfy the educational goals as specified in the development guidelines. The length of training for the professional staff depends on the needs of the trainees.

The training program for clerical and support users should also be specified in an educational plan, with specific goals for using the equipment in their area. All planning should be developed in accor-

dance with the directive of the respective bureaus, department, or office in which the support staff will be working. If it has been determined through an implementation plan that the microcomputer user has had sufficient programming experience with microcomputers through other DP equipment, the microcomputer training team should develop a self-training program.

The plan contains specific goals for the self-training program; these goals should address how the new equipment will be used. Anyone qualified for this program should also undergo the two-phase educational program.

Individuals requiring education and training through the assistance of the microcomputer training team are evaluated on completing the program. This evaluation provides the microcomputer training team with methods for improving the program. All evaluative data for participants in the microcomputer training program should remain confidential and used only to help individuals use microcomputer hardware, software, and peripheral equipment.

MAINTENANCE AND SUPPORT

Managers should consider two major areas in terms of maintenance and support of the ongoing microcomputer program: hardware support and software support. Hardware support involves staff directly responsible for:

- Speed calibration tests
- Read/write verification tests
- RAM and ROM tests
- Communications board tests
- Documentation
- Problem determination

The software maintenance and support areas include:

- Analysis of change at user request
- Change policy
- Backup and storage
- New software release applications
- Documentation
- Problem determination
- Custom-developed applications for users

Management should consider the maintenance and technical support team as necessary as the training team, since it is responsible for the upkeep of both hardware and software. It should also be able to troubleshoot users' problems. After new equipment is installed and a new user is training, the team is still responsible for that equipment. The most critical aspect of operating a microcomputer network is maintaining the equipment and troubleshooting. The maintenance and support areas encompass a wide range of preventive maintenance. The list continually evolves according to user needs and hardware and software performance.

Hardware

Hardware support should be focused directly on areas that involve the highest degree of product failure. A fact to be kept in mind is that any component of a microcomputer with moving parts is more likely to fail than a solid-state one. That is why it is very important for the maintenance team to perform preventive maintenance on such units as the diskette drives, which have movable assemblies. The maintenance team should also be able to diagnose some problems of printers, especially letter-quality printers.

The tests involved in diskette maintenance are for speed calibration and read/write verification; these two tests determine if the motor is rotating at the proper revolutions per minute and the logic subassembly and read/write head is performing properly. The most common problem with diskette drives is input/output errors caused by inability to perform a read or write operation to translate the data from the diskette to the memory of the microcomputer or from the memory to the diskette. These two tests must be performed by the technical support team to prevent such occurrences.

The next major area in hardware maintenance support is RAM and ROM tests, which involve software operations that are loaded into the microcomputer to test an operation in which memory is used from available RAM and ROM. The only option available when failures occur in this area is to have the malfunctioning unit replaced; this requires an individual with a knowledge of electronics to replace chips or boards within the microcomputer. Advantages of having a technical support team able to perform RAM and ROM tests are that the team can isolate problems and specify memory areas where the failure may be occurring. This will isolate chips that the electronic specialist or vendor can replace.

The maintenance and support team should be able to determine problems in the communications area with the use of software that performs testing operations on the communications board or the modem being used. Again, this only focuses on the particular problem area; the vendor will have to replace the unit specified.

One of the important functions of the maintenance and support team is documenting problems. Any problem that is suspected and resolved or is ongoing should be so documented; thus, if these problems recur, the actions taken to resolve them have already been specified. In addition, documentation points to hardware and software weaknesses that may be occurring chronically. Once informed of this data, the vendor can replace the units or software involved. Without proper documentation of problems, the maintenance and support team has no reliability record of implemented hardware and software.

Software

Software maintenance and support (as critical as hardware support) necessitates a staff capable of analyzing software changes re-

requested by users. When changes are made to the existing software, management must develop a policy regarding change. This policy involves two considerations: whether the microcomputer software is protected and whether staff is available to resolve and debug a problem and reprogram, implement, and test a solution. If the software is copy-protected, the only available option to change that software lies with the vendor. Most software is flexible enough to incorporate many of the changes that users may request. If the software cannot accommodate a particular request, and it is copy-protected, management's only option is to contact the vendor about the change.

If the software is not copy-protected, programs can be changed at the user's request; this, however, involves personnel and time. Depending on the software, this can be as complicated as any major programming project. The change requested must be weighed against the amount of time and staff available to make the change and support it.

Backup and storage of software are other important maintenance functions. It becomes the responsibility of the maintenance and support team to maintain an adequate number of generations of backup and storage of programs and diskettes. The real value of backups is in the time saved by organizations in not having to input information multiple times.

Software problem determination and documentation are also critical. Again, to assess the true performance of the software, a format should be established to document problems. The documentation should also specify the method used to determine the problem and resolve it. As stated previously, this provides valuable data regarding chronic problems and correcting of them.

Information Support

Information support is the use of current publications with specific information regarding the hardware and software in use or being considered. Information support can prove very valuable in avoiding unreliable software or hardware currently on the market. It can indicate future hardware and software trends. A library of information on microcomputer publications and product evaluations should be established; this information can be tapped to provide managers with indices of product performance and evaluation before purchase.

RECOMMENDED ACTION

With a microcomputer policy, management is making an attempt to be well-informed consumers of this new informational support product. Microcomputers can perform a valuable function by providing data processing or information processing capabilities in an organization. Key considerations of microcomputer implementation include the analysis of those products being considered, a working knowledge of the technical specifications of a microcomputer system, an appropriate training and development program, and proper

maintenance and support for the units once they have been installed.

The random purchase and installation of microcomputers without the type of analysis discussed here may spell disaster. Without consideration for organizational goals and objectives, cost overruns may result. IDG/T reviews a draft of a microcomputer policy to ensure that implementation and subsequent maintenance are comprehensive. Microcomputers may have begun as toys, but with technological advancements and improved software, managers are making them valuable tools and creating an alternative to large mainframe computers for supporting specific organizational needs.

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- Computer
- Computer Systems
- Computer Software Reports
- Systems Software Reports
- Microcomputer Reports
- Data Communications Reports
- Computer Application Library

Other Technology

- Information Technology
- Information Systems

Business Applications

- Business Applications
- Automated Material Handling and Storage
- Manufacturing Resource Planning
- Master Production Scheduling
- Material Requirements Planning
- Manufacturing Control Systems
- Inventory Management

Business, Finance, and Management Series

- Business and Financial Management
- Management Information Systems

Practices and Methodologies

- Management Techniques
- Management Practices

Journals and Handbooks

- Journal of Business and Information Management
- Handbooks

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An Auerbach representative will be pleased to address
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